Symposium on

RESEARCH IN AGRICULTURE

Sponsored jointly by
UNITED STATES DEPARTMENT OF AGRICULTURE
and the
NATIONAL ACADEMY OF SCIENCES

February 23 to 25, 1966
Airlie House
Warrenton, Virginia

U.S. DEPARTMENT OF AGRICULTURE

Symposium on
RESEARCH IN AGRICULTURE

Sponsored jointly by
UNITED STATES DEPARTMENT OF AGRICULTURE
and the
NATIONAL ACADEMY OF SCIENCES

February 23 to 25, 1966
Warrenton, Virginia

Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

Issued August 1966

Washington, D.C.

PREFACE

The symposium on "Research in Agriculture" brought a distinguished gathering of 55 participants from widely diverse fields of government, science, and agriculture to Airlie House in Warrenton, Virginia, February 23-25, 1966. Proposed in a letter from Orville L. Freeman, Secretary of Agriculture, to Frederick Seitz, president of the National Academy of Sciences, the symposium was jointly organized and sponsored by the U.S. Department of Agriculture and the Academy, a private scientific organization that serves as official adviser to the Federal Government in scientific and technical matters.

In proposing the symposium, Secretary Freeman described its purpose as providing "a forum of scientists and public officials who could participate with members of the [Department of Agriculture] staff in a joint consideration of the role, capacity, and need of agricultural research." He looked to the symposium to identify research goals in line with the mission of the Department and related research in the broad scientific community.

Planning of the symposium in pursuit of these objectives was carried out by a committee of four: Dr. E. C. Elting and Dr. T. C. Byerly representing the Department of Agriculture and Dr. A. Geoffrey Norman and Dr. Russell B. Stevens representing the Academy.

CRITICAL ISSUES

From the wealth of material presented at this symposium and from the spirited discussions among the participants, a number of critical issues come sharply into focus.

... The highly successful institutional grant program under the Hatch Act merits continued, unstinting support from all segments of the scientific community.

... Funds for competitive project research grants are necessary to concentrate and accelerate research on important problems directly related to the missions of agriculture. Among these are adequate food supply, resource development, community development, consumer protection and food for developing countries--especially food they produce.

... It is desirable to hasten the integration of agricultural research within the universities, within the scientific community, and among the Executive agencies. There aren't enough resources for everybody to do everything; yet the needs and opportunities in agricultural research are so varied and so important that it needs participation of all the competences in the universities -- not just those in colleges of agriculture. Agricultural research needs competences in non-land-grant universities from time to time. Industry should increase its participation. Executive agencies other than the Department of Agriculture have legitimate interests.

... Social and behavioral scientists are urgently needed -- better ones. In the universities and in USDA, too, they must provide concepts and models and test them with adequate information.

George L. Mehren
Assistant Secretary
U.S. Department of Agriculture

CONTENTS

RESEARCH IN AGRICULTURE

February 24, 1966

INTRODUCTION

Dr. MEHREN: It is very much of an honor and quite a pleasure to open this symposium. We are deeply grateful that so many were able to accept the invitation extended by Dr. Seitz and Secretary Freeman.

Dr. Seitz's people and ours from the Department have been exploring for about 6 months a variety of programs -- all aimed fundamentally at the same purpose, to find some mechanism whereby we, in the science components of the Department of Agriculture, could find some basis for a full exchange of views and ideas with other people representative of the broad scientific community at large.

I remember one Saturday morning in the office of Charles Murphy, who was then Under Secretary, his lifting his face and smiling in the angelic way he used to smile immediately prior to cutting your budget, and he said, "This is a fascinating place to work, isn't it." And it is. The Department has about 100,000 permanent people in it, and on occasion, particularly in the forest fire season, it goes up to 130,000 or 135,000.

Some parts of the American community, I think, consider that the Department of Agriculture's basic job is to find means to abstract money from the Treasury, earned by others and deposited in the Treasury by honest, hard working, taxpaying citizens, and then via price supports to transfer this kind of money to a group of lazy farmers who have been sitting on a silk cushion and being paid for not doing anything. This really isn't true. Even after 20 years of being in and out of the Department, I personally know only a relatively small part of what it really does.

Among other things it is by far the largest police agency in the entire government. We have some 40 statutes of antitrust nature, fair competition, general economic regulation, involving a scope of programs far broader in this area than the Federal Trade Commission and Justice put together.

We run an immense factory of nonfarm programs of a basic service nature, of grading, labeling, market news -- the type of information that has contributed most directly to making this economy at large what it is now. And in the absence of this battery of services you wouldn't have a Nation, quite truly, like the Nation we do have.

We are, I think, one of the major educational components in the American system, and we maintain an immense background of relationships with the States and the educational community at large, both here and abroad.

We run the world's largest fire department. George Jemisen's people are responsible for that. We are one of the biggest hotel operators in the recreational activity. We have the responsibility of about 185 million acres of national forest lands to operate.

One of the major parts of our work is to try to find means to open up equal access, economic growth to people. I would say that of all the other Departments, the one with which we deal most continuously is the State Department, because we are a major arm of foreign policy, and we are a major source of the exchange earned by the United States in foreign trade.

We do have a huge battery of stabilization activities that amount to a couple of billion dollars a year. Then I guess you people know we feed about 40 million Americans in various types of welfare programs -- 17 million kids in school lunch, special milk, 7 million on straight welfare, food operations, and in the event of national disaster, it is the job of the Department to take care of it and it does it well.

So we may be a Department of Agriculture, but as Lincoln said, "If we are a Department of Agriculture we are a Department of Agriculture in the broadest possible sense of the term." This much I do know: We are not in any real sense a department of farming. We have never been a department of farming. Our clientele primarily consists of all those in this Nation who eat or drink or wear clothes or live in houses. With the possible exception of one or two professions, that encompasses the total population of the Nation. The relevance of all this is first that few people know what the missions are, and I think they should know in order to appraise our performances in the missions or appraise our research that backstops these missions.

The real significance is that with this many different kinds of missions, it is not an easy matter neatly and precisely on paper to structure a research program that looks clean with neat, straight, administrative lines. If we can create such a mechanism, I suspect we would find it impossible to serve this immensely varied and rapidly shifting set of missions we have.

We do want critical appraisal from our selfish view here of what we are doing in the research and science side. We would like some discussion of what might be done in the days ahead.

We do know this, and I certainly know it personally: We can't live alone in our science,

in our research work. And above all else what I would like to see come out of this session is a clearer notion of what we do, on your part, and a clearer notion, on ours, of how henceforth we can maintain a closer relationship with the rest of the science community; how we can avail ourselves fully of that which is done elsewhere, and make that which we do fully available to others.

I again want to thank Dr. Seitz and his people for what is really a quite splendid cooperation during the months that we have been preparing for this session.

One of the good things about Dr. Seitz is that he is a Californian, and I have a bias for native Californians. And he is even a northern Californian. This set of virtues may be offset by what it says here, that he took a BA degree in mathematics at Stanford University. From Stanford he went to Princeton, then to Rochester, the General Electric Co., the University of Pennsylvania, chairman of Physics at Carnegie Tech. -- then the University of Illinois, dean of the Graduate School, and then vice president for research. He resigned following his recent re-election to a new 6-year term as President of the Academy.

He has a battery of writings, the quality of which I think all of us here know.

We are fortunate not merely for all that you and your people have done for us in the past few months, Dr. Seitz, but those of us here are honored to have you open our meeting in the role of the scientist in a world agricultural situation.

Dr. Seitz.

THE ROLE OF THE SCIENTISTS IN THE WORLD AGRICULTURAL SITUATION

By Frederick Seitz,
President, National Academy of Sciences

When I was first asked to speak to you, it was quite clear that I would be an inexpert minority representative among a group of scientists who would do most of the talking. As a result, it is most appropriate that my remarks have been moved from first to second place.

In present day society science is called upon for two major responsibilities. One is to accumulate knowledge. This is the aspect of science that intrigues a young man most and lures him into science or, in fact, into any other field of scholarship. Starting with his school days he becomes involved in scholarly activities, and if he selects a scientific career sees research as a way of making his mark in a growing professional field. The success he has in bringing distinction to himself gives him great satisfaction.

Ultimately, society may ask something more of him and as he matures he is pleased to respond to this demand. We live in a complex world that faces innumerable social problems and challenges. The scientist has the obligation to help resolve some of the problems if it lies within his aptitudes to do so. As a matter of fact, it is quite clear that in our own characteristically American society the citizens at large, and, in fact, most of our leaders, value the scientist not so much on his own terms as an imaginative and thoughtful scholar but as an individual who under the right circumstances can respond to social challenges, or to use the language of the day, can make a significant contribution in our advance toward the Great Society. Ipersonally do not feel that we should shun this role, since I regard it as self-evident that the concept of the Great Society will have to become global if our species is to live in peaceful productivity in the century ahead. I might also add parenthetically, that in responding soberly to the expectations of society, we also have a right as scientists to expect that society will provide our professional fields the wherewithal to continue their advances in accordance with standards that the professional scientists regard as acceptable. Our responsibility toward society includes preserving the integrity of our professions.

Viewed in the large, there are two significant levels of concern in the field of agriculture. One is associated with the problem of gross calories; the other with the refinements of nutrition. The first of these has not meant a great deal to our country since the war. We have actually had an overproduction of calories for our own needs and a reasonably good system for distributing them. There has, in fact, been a nominal "overproduction" of calories for a number of decades; however, the distribution was quite uneven until relatively recently. It will be of interest to you to recall that in 1940, when the first draft of the Selective Service Act was called, it became evident that the maldistribution of food during the great depression had been sufficiently great for many of the young men called into the army to have been victims of malnutrition. At that time our Government called on the National Academy of Sciences to create what is now the Food and Nutrition Board to study this problem and to provide advice to our Government on ways of remedying it in the national welfare. That Board is still quite active, although the major issues to which it devotes itself are now of international, rather than only of national significance.

The second great problem associated with agriculture, and which I have already mentioned, is related to the refinements of nutrition and is an issue everywhere. In our own country it has to do with making certain that growing children have a well-balanced diet and that older people will know which foods best suit their own health and way of life. On the global scale, we have, among others, the problem of protein malnutrition in the preschool child that is related partly to tradition and partly to inadequate agricultural capacity.

Let me turn first to the grosser problems of calories in our world today. The global statistics make gloomy reading. The population of our planet is currently doubling about every 35 years. In certain areas -- for example, in India -- it is probably doubling in about 25 years, although the vital statistics are not accurate enough to be certain. In contrast, the agricultural output of the world is doubling at a slower rate, only every 50 years or so and is inevitably limited by the rate of technological innovation. In India, the doubling time for agriculture is somewhat nearer 70 years. Thus, worldwide, there is great disparity between the growth of world population and the growth of agricultural products. The imbalance is even more marked in certain large geographical areas of which India is typical. It follows that vast populations of our planet face disaster in the next decade or two. In fact, India, which is currently absorbing something like a third of our wheat production, already faces famine conditions. While this famine is accentuated by the recent droughts, it will be a continuing state of affairs if the rates of increase of food production and of population are not brought more nearly into line.

To accentuate the gravity of the situation in India, I might remark that that country faces a wave of deaths each winter as the temperature in many parts of the land heads toward freezing. A large segment of the population is living so close to the borderline of life, because of malnutrition, that it simply does

not have the vital energy needed to adjust to the drop in temperature.

Perhaps I should not focus so much on the problems of India. The facts for that land are, however, rather fresh in my mind because of a visit I had there in January. As a result I would like to say a few additional words since the situation is, after all, characteristic of many other parts of the world. During the trip I had an opportunity to spend a day with Dr. Cummings and his staff at the Rockefeller Foundation Center in New Delhi. This group is deeply involved in India's problems of food production. It works in close cooperation with other foundations and with the Indian government carrying on field research of the type that has been so successful in Mexico. It became evident from the discussion that there is ample knowledge in hand to double food production in India in the next 5 or 10 years, provided all the proper steps are taken. Genetic strains of maize, sorghum, wheats, and rice are available that would give much larger yields -- provided fertilizers and other care are furnished. Achieving this goal, however, requires access to certain kinds of industrial products; for example, modern fertilizers. The development of such industrial production, on the other hand, would require what for India is an enormous investment -- of the order of 30 billion dollars, which in fact, is about the annual gross national product of the country. Since it is essentially impossible for a nation to invest one year's GNP in any given field of industry in a short period of time, the country clearly faces a very great dilemma. The only salvation would be to procure foreign capital for the required industrial innovations. Although it appears that the required capital could be obtained, the Indian government is not at all certain that it wants to accept foreign investments on the required scale. Thus, social and economic attitudes have become deeply involved in the problem of satisfying the basic agricultural needs of a major population.

The problem of the welfare of India, one of the great democratic nations of the earth, is so important to all of us that I remain optimistic in the belief that it will be solved in our time. That is, that Indian agriculture will eventually rise to meet the challenge it faces. One reason for being optimistic is that other nations faced with similar problems have overcome them.

Mexico, for example, has undergone an agricultural revolution in the last 25 years. During this period its population has approximately doubled, but its food production has gone up by about a factor of three so that it is changed from a food importer to a food exporter. The factors that brought about this revolution illustrate the key to success. In this instance, Mexican agricultural scientists, working in close cooperation with United States scientists supported by our philanthropic organizations, developed new disease-resistant strains of the primary agricultural plants. In connection with this, the Mexican government used some of its currency both to import appropriate fertilizers and to help create a fertilizer industry within its own borders. Thus, the entire agricultural economy was given a great new thrust. India's problems are graver and older, but there is no reason to suppose that they cannot be solved using the same basic principles.

Looking farther to our south than Mexico, we note other nations that face agricultural crises. One of these, which was a major food exporter several decades ago, is now entering into a period of grave difficulty because its policies in relation to land use have not kept up with changing conditions. The descendants of the original prosperous farmers have become absentee landlords and are more interested in obtaining an income from the land that will let them live a life of ease than in putting the land to work for the entire population. In cases of this kind it is clear that land reforms must precede the application of scientific methods to farming.

Turning to the refinements of nutrition, I might call attention to an international conference which the Academy's Food and Nutrition Board held a year ago on the problem of malnutrition in the preschool child -- that is, the child who has been weaned, but is not yet able to participate in the normal dietary pattern of the adult. There are many areas of the world in which there is exceedingly high mortality among the children in this age group. Moreover, many of those who do succeed in living through it emerge with permanent weaknesses. A study of this situation in Asia and Africa shows that in many cases the calorie intake is not inadequate; however, the foods used are often highly deficient in essential constituents, particularly proteins. Moreover, the malnourished child is highly susceptible to a variety of diseases, both functional and infectious, which may either kill him or leave him permanently weakened. There was a consensus among the more experienced individuals who have faced the problems of the preschool child that the greatest single obstacle is the ignorance of the parents and grandparents, particularly the grandmother. What is needed first and foremost is a shift in the diet of the preschool child and more attention to elementary sanitation. The shift in diet means a break in the traditional agricultural pattern. This should not be difficult in situations in which calorie production is essentially adequate. A few new types of foods higher in proteins and other constituents would, of course, have to be introduced.

I think the remarks I have made here make it amply clear that the scientist involved in world agricultural problems must in one way or another be sufficiently flexible to recognize that such work will inevitably take him into the middle of matters of major social importance. Whether one is attempting to convince a mother or grandmother that the young child

should be eating a different diet or is trying to convince the leaders of a nation that they do have responsibilities in the field of population control, one is inevitably involved in social issues.

Our community of scientists in the United States concerned with such problems clearly has an enduring responsibility. We not only have our internal problems related to feeding our own population adequately but we also can scarcely avoid helping other countries, either by providing them with critical information relevant to their own agricultural problem or by helping to adjust our own food production so as to enhance the potential export to them. It seems clear to me that the second issue will be one of growing importance as the years roll on. The task of solving the international agricultural problem obviously could not and should not rest only on our own shoulders, but I do not see how we can avoid playing our part without presenting our own descendants with the very grim prospect of living on a planet constituted mainly of slums.

The Department of Agriculture could and should play a leading role in our country as we enter into this new era of significant agricultural research. Looking over the record of the Department, I must confess that I feel it has become dreadfully ingrown, living in effect behind a prison wall of its own construction. The Department has done an excellent job in serving our country in the rather narrow but important sphere of responsibility it has cut out for itself in the past. However it does not seem to have been able to recognize, as the present century progressed, that it would have major new challenges to face. Those challenges are now upon us.

For many years the Academy has maintained an Agricultural Board explicitly designed to give voice to those concerned with the major agricultural problems of our time, in keeping with the traditional responsibilities of the Academy. I believe that it would be to the best interest of the Department of Agriculture to recognize the importance of such a board and to help support it. The Department has chosen in the past to minimize its association with this and other outside advisory bodies. I wonder if the time has not now come to reconsider this issue and others related to it.

Dr. MEHREN: It seems to me that Dr. Seitz has identified one or two things which I think are awfully good examples of some of the research difficulties we have as a mission-oriented operating research agency.

It is true that we are committed to try to help in situations like India and elsewhere. It is also true, beyond any question, I think, that we cannot feed India, we cannot feed Pakistan, we cannot feed the people of the earth who already need help.

It is true, I think, that Canada and the United States at the moment, and for the foreseeable future, are the only ones who can make aid available through food.

I think that probably the most impelling observation I heard from Dr. Seitz is that we do not have the appropriate backstop of research whereby we can conceivably use the technology that has been developed here, make it viable and operational elsewhere, supplemented with food.

But the difficulty, as I see it, Dr. Seitz -- and perhaps you would comment on this -- is that I don't know how to design or structure a research program which would specify the targets by which we would measure development in India or anywhere else, identify the determining variables and relationships, and thus give us a systematic and rational basis for the development of an operating program with some hope of an autonomous or indigenous capacity in countries like India to feed themselves in the future.

Is there work being done elsewhere which is trying systematically to specify the kinds of research backup that would be needed with our commitment to countries like India and other parts of the world? We also have the same commitment here domestically to try to generate economic growth, development in Appalachia, and other parts of the Nation. I don't know of any appropriate research backstop in our activities for this. If there is one in which we are out of balance, this is it. Would you comment on that, sir?

DR. SEITZ: As I said, the Rockefeller Foundation, with a very small investment judged by any Federal standards (I don't know what was put into it, certainly not over $20 million) and with a corresponding responsibility from the Mexican Government and scientific community, was able to effect what is little short of a major revolution in agriculture simply by doing the things that were needed on Mexican soil. They established a research center near Mexico City in the most arable lands in the area and found genetic stock that was resistant to the local blights.

In New Delhi I spent a day with Dr. Cummings and his Rockefeller group of about 20. I also spoke with those who were in Delhi and another 20 or so out in the countryside. I should add that they are working very closely with the Ford Foundation. In a room half this size they had many, many exhibits of sorghum and maize showing the kinds of responses they could get -- work that had been done over,

let us say, 10 years. Dr. Moseman could probably give some figures of what the amounts were.

As I say, in India one hasn't had the response that one has had in Mexico and I don't say that is trivial. But I think the technique is there. With the resources of the Federal Government, one might not be able to speed this process by a factor of a hundred, even if you were willing to invest a hundred times as much money, but there would be some gain of a significant kind.

MR. MEHREN: Dr. Byerly?

DR. BYERLY: Dr. Seitz has raised some very important issues. I would like to comment on one and ask a question.

First of all, with respect to what you say in New Delhi, I suspect one of those sorghums had a Texas parent. At least it did when I was there.

DR. SEITZ: That is right.

DR. BYERLY: This only says one of the things which is obviously true. Rockefeller [Foundation] has been an amazingly successful catalyst. Cummings once worked for one of the land-grant colleges; Statesman, an advisor in Mexico, from another. And Rodenheiser, my friend of many years, was a consultant there and continues to be so. This is the tip of the iceberg. We haven't done enough and we want to do more.

There is a current issue that you have raised. Famine in India is no new thing, as you know. The record indicates that since the 14th Century, when records were first established, they had a major famine at least once a century. Some of those famines lasted as long as 12 years. And famines of direct loss in the smaller populations resulted in as many as 10 to 12 million direct deaths in the days when they didn't count very carefully.

The Academy has been one of the agencies recently that has reviewed the whole area of weather modification. The reason we have a problem in India right now is on account of the weather.

I wonder if you would care to comment with respect to how the executive agencies, the Academy, the Foundation, and all of us, can -- if the time is ripe and timely -- do something about the weather. Ought we not look forward to doing something more effectively?

DR. SEITZ: I might say that the Academy's report on weather modification was the center of a rather significant human debate. I don't want to go into the details, but the first response of the committee which looked into the matter was to say that it was premature to hope for anything significant. But then, as a result of issuing a draft report, some of the individuals who do weather research privately, and don't have a tradition of publication, got worked up because of what was said. They felt they were being put in a bad light, and came forward with information which indicates that under exceedingly favorable circumstances, such as the West Coast, one can have an effect on the snow burden of 15 percent, perhaps. It became clear that if the natural situation is suitable, and if you understand it to some degree, you can cause a change.

The Indian situation, as I understand it -- and I am not a weather modifier -- arose from the fact that monsoons in some regions came late, and in other regions didn't come at all. I doubt if at the present time we have any very great understanding of the details of the monsoons. Moreover, I also have a feeling that affecting them is a much larger problem involving knowledge over a larger portion of the globe than, say, the 500 or 600 critical miles along the Sierra Nevadas.

The significant part of the report on weather modification is that it recommends that more effort be put into the basic understanding and experimental side. It doesn't offer promise that, say, within 12 years -- if that indeed is the time that is critical for India -- that one could do very much there.

DR. MEHREN: Dr. Aldrich?

DR. ALDRICH: I would like to comment to a point that Dr. Seitz made.

I think there is a tendency on the part of those of us who have long been engaged in agriculture to immediately respond when comments are made about the adequacies of our programs in terms of our accomplishments in the biological and physical science dimensions of our programs to indicate that really we have the basis for doing a great deal. If you take a look at programs in India or Mexico or Chile, such advancements that have been made there come back to basic contributions that we have made in the agricultural sciences either here in the U.S. Department of Agriculture or in the land-grant institutions of this country.

I am particularly concerned that we too often offer rebuttal in this fashion and do not concern ourselves with the social and political institutions that must be investigated and studied to better apply some of the know-how we have in the physical and biological sciences.

I would have to say that over the years I recall well some of our own staff returning from India or other parts of the world, commenting rather forcibly about the waste of time that some of our colleagues out of the social and political sciences are faced with -- that they are wasting their time as they explore village development and community development.

They have rather quickly disposed of that effort and said what they really should do is be applying fertilizers or they should be reclaiming land or they should be setting in motion new varieties. That is really the solution to their problem. And the notion of the social and political institutions that India or Chile or Mexico is struggling with really is not particularly productive or meaningful.

I think this has been an error on our part: That agriculture should have embraced the social and political scientists and through them enabled us to devise or work with people

to produce the institutions that more appropriately apply the know-how that we have had here.

We have been fortunate to have social and political institutions in this country that facilitate the application of the biological and the physical science know-how. But as we go abroad such institutions don't exist.

DR. MEHREN: Dr. Ruttan?

DR. RUTTAN: It seems to me that our work in this international agricultural development has suffered greatly from three very large oversimplifications. I was very pleased that Dr. Seitz emphasized the simplification that we get about our job of producing new varieties that this will solve the problems. His emphasis on the investment that is necessary to go with this seems to me to be extremely important. In some areas it is irrigation, in some areas fertilizer, in some areas a combination. In the Philippines, for example, the new varieties will achieve their potential only on 200,000 out of the 3.2 million acres because of the investment in irrigation.

It seems to me that there are two other oversimplifications that were implicit in his discussion. One is that we have a technology to transfer. My own work in Soviet Asia with the Rockefeller Foundation has led me to the impression that we don't have the technology to transfer. What we do have is research proposals to problems in these regions, but the research must be highly location-specific.

The second has to do with food aid and implication of our food surplus. I am impressed by the observations of a good many people in India and elsewhere that filling the food gap through food aid widens the gap it is intended to fill. I think this is something we must very seriously consider before we conclude that the current developments imply we are not an agricultural surplus country.

DR. SEITZ: I tried to emphasize the fact that if we are to do any good for the other countries, it must be done working with them in their own environment. I don't think one can in Illinois and Iowa do the critical research that is going to be important for India or Africa. The work in Mexico required the establishment of one or more stations in Mexico in the regions where the stock was to be raised. I think that is generally true.

DR. MEHREN: Mr. Cain?

DR. CAIN: As a person not in the Department of Agriculture let me remark that 30 or 35 years ago the Department of Agriculture was starting in many areas to do exactly what it has been called on to do today. I will mention two brief illustrations. I started one time looking into the processes of innovation and acceptance and found that through the interests of the Soil Conservation Service in the 1930's, and the work of rural sociologists connected largely with land-grant colleges, there were at least 100 papers -- I don't know exactly how many but I quit because I found enough for my purposes -- [dealing with] this process of finding out what are the countries under which an innovation can occur, be accepted, and the rate at which it will spread, by identifying the kind of people who accept and who are leaders within. This is one of the problems that Dr. Seitz has in mind, I am sure, in the application of the sciences of agriculture to the spread of the practices.

Another illustration that occurs to me, I think also in the early 1930's, when the Forest Service employed some sociologists and psychologists, because there was a forest fire problem in Arkansas and other places which was completely irrational. They had to find out why the people were setting fires, what the basis of their antagonism to the Forest Service was. It turned out to be not a very difficult problem to solve. It wasn't a natural science problem, but a social science one. This early beginning approach suggests that one needs to put in the Department of Agriculture, Department of the Interior, and so on, some of the social sciences which will give us information to help apply the natural sciences.

DR. MC ELROY: I understand the Mexico experiment is an establishment in part of these five experimental laboratories. Are you suggesting that the Department of Agriculture take the responsibility of establishing laboratories in other countries of the world and actually attempt to man that by technical people from the United States?

DR. SEITZ: I think that would be an excellent thing to do, assuming Congress will accept it. I am rather inclined to believe it would -- especially if it were a program, so to speak, directly supervised by the Department so they would know whose hands it was in.

DR. MC ELROY: Do we have the scientific manpower to do that?

DR. SEITZ: I don't know.

DR. MEHREN: Perhaps I can speak to that. There is a proposal within the Department that has been discussed rather deeply for about 6 months with respect to the possible establishment of some four regional laboratories in different parts of the earth, in keeping with some recommendations that originated in the Academy.

My difficulty in participating fully and with a whole heart in a proposal of this sort is that I think I have seen too many pale shadows of Ames, Iowa, in places like Seoul, Korea, and I am not at all certain that I know what kind of a laboratory, staffed by what kinds of people, engaging in what specific types of questions by what specific methodology really will contribute directly and affirmatively to the generation of development in recipient countries.

I think that the pale shadows of the American experiment stations in some countries may well have done more harm than good. And I am not personally ready to proliferate them merely to have some more laboratories out on the face of the earth. I would like to know and get some help in learning what kind of laboratories [are needed] to do what functions

through what mechanisms. If those questions can be answered, I am certain that Secretary Freeman almost immediately will get the wheels rolling and we will find some way to get the staff.

DR. MC ELROY: I was under the impression that one of the reasons for the Mexican success was because they brought Mexicans into the laboratory and tried to train them, and that they became aware of their problems, and this had the social feedback Dr. Aldrich is talking about which is an important one.

DR. MEHREN: I would like to go back to the point Mr. Cain and Mr. Ruttan made. Also in Mexico, for reasons probably not clearly known to any of us, there was an acceptance of an adapted technology. The determinants of that willingness and forcefulness in accepting technology is pretty much of a blank spot so far as I know.

DR. MOSEMAN: I am with AID by way of the Rockefeller Foundation. The work in Mexico was initiated by the Rockefeller Foundation in 1943. If you look at the essential takeoff in wheat production, it didn't really occur until about 10 years after that time. There were a number of factors involved. There were several improved wheat varieties that were developed during that first 10-year period so that the Mexican farmers became somewhat accustomed to innovations that were well tested and well proved. When the short-straw varieties that have the capability of utilizing about 120 pounds of nitrogen and producing up to 100 bushels and more per acre came along, the Mexican farmers were ready to accept them. This is demonstrated by the fact that within 3 years 85 percent of Mexico's wheat acreage was taken over by these varieties.

As far as trying to establish U.S. institutions or their counterparts abroad, I think the one thing we have to watch is that we don't build something in the countries that we are trying to help that becomes a constant millstone on our neck and our taxpayers. I think it is important that we build on and in local institutions.

A question was raised about India. Although I was going to touch on this in my talk on Friday, I might refer to it here because it does relate to what Ruttan mentioned as locations for specific research.

In India, back in 1950-55, if you went to the research stations you found that there was a lot of so-called agricultural research carried on, but most of it was rather esoteric, academic. It was not really applied to the problems of the land.

Two weeks ago I heard the director of the Indian Agricultural Research Institute, express it this way: He said if you go to an Indian Agricultural Research Institute and ask them if they are working on the problems of the farmer, they rise up indignantly and say, "Of course, we are."

Then you say, "I am a farmer. I have a fine sandy loam soil. I am trying to raise these particular crops in rotation. I have these insect and disease problems. What are you doing for me?" And the answer is, "We are not working for you."

In 10 years or so, with the Rockefeller Foundation activities assisting in developing national coordinated research schemes, the pattern in India has changed quite a bit. What we are hoping to do in India through the efforts of the Rockefeller Foundation, the International Rice Research Institute, and five of the U.S. land-grant colleges, is to establish an agriculture research and development system that is not too far different from what we have in this country, with the USDA furnishing a certain amount of national support, coordinated leadership. In India, the counterpart of this is the India Council of Agricultural Research working with them through the Rockefeller Foundation staff over there -- pulling in the International Rice Research Institute to furnish additional support at that national level.

To address the location-specific problem, we are hoping that we can strengthen the U.S. land-grant institution activities in the seven universities that have been established by seven of the Indian states, and tie this into a national coordinated program or series of programs that would be working on the improvement of the major food grains, including wheat, rice, sorghums, and millets.

As Ted Byerly said, we are working at the tip of the iceberg. We are drawing on the resources not only of the land-grant experiment stations but of the USDA, and not only from the U.S. institutions but also from Japan and elsewhere.

If you trace back the origin of the Mexican wheats that have been highly publicized for their production in Mexico, you find that they go back to the little Island of Takamatsu in Japan with Dr. Este Solomon of the USDA. So I think we are benefiting from the institutional experience that we have had in this country.

VOICE: Does this include education and training of people?

DR. MOSEMAN: Yes, very definitely. One of the things the Rockefeller Foundation did was establish an agricultural school at the India Research Institute. At the present time they have about 400 students, half of whom are taking Masters and half Ph.D. degrees. They are also helping to build in agricultural programs in these agricultural universities.

DR. MEHREN: I would much rather stay with questions. We will have one more.

DR. BATES: I want to add emphasis to what Dr. Byerly spoke about before. I feel the word "famine" cannot be said without thinking immediately of a common word that goes with it, namely, drought.

It seems to me that with regard to weather modification I would agree with what Dr. Seitz has said. But I think we have a situation in India where just as a temperature of 50° F. can put certain people over the hump, we have

a sensitive situation where a quarter inch of rainfall at the right place at the right time can also affect the balance.

I would say although NSF reports are properly conservative with regard to this situation, as perhaps they should be, that I cannot go along with the idea that we must look only for the simplest natural occurring situations in which to begin to work. I don't think we are anywhere near ready to work on monsoons.

I know that some of the work in this country that has been quite successful has been in my area of the Appalachians where the situations have been extremely complex. In Pennsylvania we have accomplished some real results in very complex situations, not because the situation was simple but because we put the effort into engineering research as well as basic research study areas.

I go along completely with what the President said last fall --for obvious reasons-- that we can place weather modification now in the same category as nuclear energy and going to the Moon.

DR. MEHREN: Are you saying this for obvious reasons or are you saying it because the President said it for obvious reasons?

DR. BATES: I am saying it for obvious reasons. Let me say from the standpoint of the Department of the Interior, we welcome agriculture getting wholeheartedly into this business from the standpoint of proper water resources. I am of the very positive view that it is high time that we did things that we were not doing 10 years ago from the standpoint of engineering research. I think we can do them in India, not necessarily on monsoons but in critical situations.

DR. MEHREN: There will be a great many things we will talk about when we get home. I am grateful to Dr. Seitz.

Let us recess.

(Recess)

DR. MEHREN: Gentlemen, let's reconvene, please.

Our next speaker is Dr. Harvey Brooks, whose background involves Cleveland, Ohio, Yale, Cambridge, Harvard, and working during the war on sonar and the homing torpedo, with which some of us who did duty in the Navy are reasonably well acquainted, working in the General Electric Co., in a small theoretical physics group which later became the Knolls Atomic Power Laboratory.

In 1950 he became the Gordon McKay Professor of Applied Physics at Harvard, and Dean of the Division of Engineering and Applied Physics in 1957.

He has done a great deal of work on the Undersea Warfare Committee, National Research Council, the advisory committee on reactor safeguards of AEC, the Naval Research Advisory Committee, the President's Science Advisory Committee, and the National Science Board.

I think that Dr. Brooks has done as much as anybody else in the science community and in the general relationships of science and public policy. He has several papers on this. He is presently the Chairman of the Engineering Section of the National Academy. He also founded the international journal, "Physics and Chemistry of Solids," and has been its editor in Cleveland ever since.

Dr. Brooks spoke in Charlotte last night, and he speaks in Norfolk tonight. I am most grateful that he can come with us today. His speech has a beautiful title on "Organizing Research for Social and Economic Objectives: An Outsider's Appraisal of the Strengths and Weaknesses of Agricultural Research."

Dr. Brooks, we welcome you.

(Applause.)

ORGANIZING RESEARCH FOR SOCIAL AND ECONOMIC OBJECTIVES: AN OUTSIDER'S APPRAISAL OF THE STRENGTHS AND WEAKNESSES OF AGRICULTURAL RESEARCH

By Harvey Brooks,
Dean, Division of Engineering and Applied Physics, Harvard University; and
Chairman, National Academy of Science Committee on Science and Public Policy

In looking over the program and the audience, it is immediately evident that my contribution to this conference will be unique in at least one respect. Of all the speakers -- and I think of almost the entire audience -- I am the least qualified to speak on any subject connected with agriculture or agricultural research.

On the other hand, in at least one respect my participation may be slightly appropriate. As Chairman of the Committee on Science and Public Policy of the National Academy, colloquially known as COSPUP, I have become increasingly concerned with the coupling between science and its applications and with the process of translation by which basic science eventually is transformed into socially valuable results.

One might express the relationship between science and society succinctly as follows: Society wants results, and scientists want support and freedom. Society has increasingly realized that if it wants results it must accord scientists at least a degree of freedom to pursue their own objectives in their own way; while scientists, especially those concerned with science and public policy, have come increasingly to appreciate that science itself cannot expect continuing freedom and support unless at least some scientists concern themselves with the processes by which the findings of science are ultimately translated into things society wants and can appreciate.

Thus in a series of studies of needs and opportunities of the various basic science disciplines which have been sponsored by COSPUP, we have tried to focus the attention of the individual panels on the contributions which each discipline has and can make to national objectives, such as economic growth, health, defense, and so on.

More recently we have been thinking about a study of applied research and of the various mechanisms by which science finds its way into socially useful applications.

Throughout the world, developed and underdeveloped alike, it seems to be an accepted article of faith that science and technology will save us. But there is remarkably little explicit understanding of how this magical process occurs or will occur in the future.

What could be more natural, then, than that those of us who are interested in the process should turn first to what is in many ways still the greatest success story of the translation of science into application, namely agricultural research, to see what lessons can be learned which are generalizable and to define which of the experiences is unique to agriculture.

In attempting to draw these lessons, we must not fall into the trap of relying too much on history. In science and technology nothing fails like success. History is waiting to belie the successful scientist or engineer who looks confidently into the future and, on the basis of his past experience and reputation, predicts what will and will not work.

Agricultural research today exists in a far different environment than it did 30 years ago when the present patterns of organization and support were already fairly well settled.

A simple statistic, I think, brings this out clearly. In 1938 agricultural research was about 40 percent of all federally supported research and development, and the Department of Agriculture was the largest single agency supporting research. And through the State matching program it had even greater leverage than would be indicated by Federal funds alone.

Today agricultural research is a far larger, more diverse, and more comprehensive enterprise than it was in 1938, and yet it is less than 1.6 percent of federally supported research and development. Perhaps more to the point, it is probably no more than 10 percent of federally supported research in the life sciences. Its share of the most highly trained manpower in the sciences is probably substantially less than 10 percent.

Let me try to give an impressionistic history of federally supported research and development since the founding of the Republic. Since this will take approximately 2 minutes, it must be regarded as slightly oversimplified.

One can nearly say that Federal research and development didn't exist prior to the Civil War. Federal involvement in science and the application of science began seriously in the 1870's. As a matter of fact, the National Academy of Sciences played an important stimulating role in this development.

What might be called the earlier Federal science extended about from the 1870's to about 1915 when the establishment of the NACA began a somewhat new pattern in Federal science support which is something of a forerunner of the present situation.

The early characteristic of federal science was that it was closely tied to fairly clearly defined social objectives -- food production, the finding of natural resources, the establishment of industrial standards. In general, the technology was rather specific and unique to the objective. One could almost say that the scientific discipline and the object of research were identical.

Agriculture existed as a scientific discipline in its own right. It used only a few general biological principles which extended beyond the confines of agricultural science, chiefly the Mendelian laws and the principles of evolution. For the rest, the content of the

science was defined by particular objects of study -- the economically useful plants and the specific parasites which preyed on them.

This was an era of science which was largely descriptive. And I think the case of agriculture is typical of other examples such as the Geological Survey, Bureau of Mines, Fish and Wildlife Service, and so on, about which one could say, at least fairly accurately, that the science and the objectives were more or less congruent.

The techniques were primarily, although by no means exclusively, those of observation rather than of experimentation.

World War II obviously constituted a watershed in this process. The dominant viewpoint in World War II was that of the physical sciences, especially physics -- of all the sciences, that which is least concerned with the particular, with the uniqueness and distinctness of objects of study, rather than their generality. Physicists in general have a less specialized point of view. What has come to be called the whole problem approach, which takes nothing as given, was characteristic of the wartime effort.

Furthermore, wartime and postwar science was little concerned with the social and economic boundary conditions within which science had to be applied. Technical considerations dominated decisions with little influence from the marketplace in the broad sense.

To pursue a little further the contrast between the old pattern and the new in government science, I think is instructive, and I have set down a series of parallel statements about the old and the new. Obviously these are exaggerated, and every statement about each has to be qualified by counter-examples. Nevertheless, I think the generalizations have some validity.

In the first place, the old pattern consisted largely of in-house research. Even the large extramural program of the Agriculture Department, for example, was primarily in schools of agriculture and agricultural experiment stations which to some extent were wards of the Agriculture Department, segregated from the rest of the university complex and therefore having at least partly an in-house flavor.

On the other hand, it is characteristic of the new pattern that there is a very large delegation of initiative to the private sector -- to independent research units and individual scientists.

The old pattern was characterized by a high degree of dispersion, both geographical and in respect to number of small units. The new pattern is characterized by considerably more concentration. For example, if one looks at federally supported research and development outside of Government laboratories, which is nearly 85 percent of the total, something like 50 percent of research and development funds are spent in only 5 private corporations, and about 50 percent of university research funds are spent in about 20 universities.

The old pattern is primarily institutionally oriented. One determines essentially how much money various institutions are going to get and then only after this general determination has been made does one begin to define the program in terms of projects.

On the other hand, the new pattern has primarily a program and project orientation, with institutional support falling out as a byproduct of programs and the selection of projects.

The old pattern was characterized by very strong coupling to the users and to the market. In a sense it might be called market directed, whereas the new pattern involves a high degree of technical autonomy in the performing organizations. In a sense one might call it science or technology directed.

The old pattern was characterized and is characterized by rather close Congressional scrutiny and control, which in turn reflects considerable control and influence of both the economic and the scientific constituency. The new pattern is characterized by rather weak Congressional and very much relatively stronger Executive program control. The old pattern is characterized by relatively weak coupling to the external technical community outside the immediate technical constituency of the agency. The new pattern is characterized by rather strong coupling to the nongovernment scientific community and a rather high measure of influence of the nongovernment scientific community.

One might say that the old pattern -- and I think this is particularly true in the Department of Agriculture, although to some extent it is true in the other older departments, too -- is characterized by what I would call a need-oriented organization and need-generated projects. One only has to look at a description of the research program of the Department of Agriculture to see its very strong orientation towards the explicitly defined needs of the various groups which it serves.

The new pattern is characterized by what I would call an opportunity-oriented type of orientation. That is to say, it centers in science and looks toward the way which specific scientific projects can serve needs rather than starting with needs and designing projects to serve those needs.

The old pattern has a tendency in terms of needs to try to cover a great many bets, to do something with all the relevant technologies. The new pattern is characterized by a tendency towards greater selectivity.

Of course, I have overdrawn these differences because in many respects they are not simply characteristic of the old and the new; they are also characteristic of the different nature of the clientele which is served, for example, by the Agriculture Department or the Interior Department or the Commerce Department as compared with the clientele that is served by the Defense Department or NASA

or the National Science Foundation. Obviously, agricultural research would have been completely useless unless a very large clientele could be induced to accept and use its findings.

In defense and space, only a very few key decision makers really have to be convinced, whereas in agriculture you have to convince a very wide group of farmers.

Even in basic research the clientele -- the user -- is essentially a small group of basic scientists in the same discipline.

The case of health research is particularly interesting, I think, because in fact in many ways there is what appears to be an a priori analogy between the field of health and the field of agriculture. Therefore, if there are differences in the organization of health research and agricultural research, at least some of them may be due to the fact that health research came to maturity later.

Health research in fact adopted some of the superficial characteristics of the old pattern of agricultural and other research, while operating essentially according to the new pattern. The National Institutes of Health were organized by disease categories, and in this sense the NIH was need-oriented. But if one looks within the disease categories to see how projects are chosen, one can see immediately that the choice of projects is largely dictated by opportunity rather than by need.

The clientele that has to be convinced is mainly the researchers, not practicing physicians. Congress was clearly convinced by the wartime pattern that the opportunity-oriented approach was superior. If you will, they looked to this to produce mutations in the applications of science rather than merely natural selection and evolution in the application of science.

Can we say anything about the comparative merits of these two patterns? One might argue on the one hand that this is not a meaningful question, that, in fact, they are simply appropriate social adaptations to the goals which they serve, and each pattern is appropriate to its own sphere. I think there is some merit in this idea, but the example of health research makes one pause before accepting this as the whole explanation of the difference. Or one can go to the opposite extreme and simply argue that the difference in pattern is entirely of historical origin. The agricultural pattern dates from the era of the weak executive, of "little government", subject to a high degree of influence by local and regional interests. The so-called modern pattern dates from the era of the strong executive, somewhat weakening Congressional control, growing influence of outside experts and powerful internal bureaucracies, plus a general tendency of Congress to be much more permissive with respect to anything that touched on national security as compared with other fields. And in this sense I think health occupies a position that is in some respects analogous to national security, since from the point of view of a man over 50 health is probably a more immediate and urgent concern even than war.

Are there any measures of success of one pattern over the other? Clearly for the pattern of agriculture the criteria of success are quite evident. The productivity increases in agriculture and forestry have exceeded any other economic sector so far as I know, and this has been the trend for something like 50 years. In spite of the tremendously increased productivity of agriculture, we have at the same time succeeded in conserving and building up our potential productivity even faster than our actual productivity. I have heard economists seriously argue that agricultural research has been a dismal failure, a misallocation of resources, because in fact productivity research has built up surpluses at rather large national cost while utilization research has failed to find ways of consuming them. And economic research has failed to find ways of spiriting them away.

Perhaps this argument is not completely devoid of merit. On the other hand, in the context of the world with which we are faced today, with two-thirds of the world's population underfed, I cannot believe it was a national mistake to build up our productive resources and our potentiality for future food production.

Another point that I have sometimes heard made is that agricultural research didn't really pay off until scientific developments from outside the field of agriculture were exploited. I have in mind particularly such developments as pesticides, antibiotics, the applications of radio-activity, and so on. However, this argument doesn't impress me too much, because it is evident that it would not have been possible to exploit these developments from outside agriculture if a magnificent organization for the application and diffusion of technology had not already existed in the agricultural organization.

Furthermore, I am reminded by my agricultural friends that the antibiotics did not become important -- something that could be produced industrially -- until the fermentation laboratory of the U.S. Department of Agriculture showed people how to actually produce penicillin.

It is much harder to find cost-benefit criteria for other research areas. First, because most of the purposes of federally supported research are noneconomic and our statistical system is such that we have no objective system of social accounts analogous to our national income accounts.

It is true our health has improved, but by any statistical measures there are several other countries that spend a considerably smaller amount of money on health research and yet have better statistics than we do. In fact, there are some people who believe that we have failed to utilize maximally the results of research that we have so magnificently produced in the field of health.

In other words, the coupling problem, as I have called it, may have been neglected in the health field, so that the progress of science may have outrun our present capacity to organize and apply it.

In the national security areas it is much harder to devise statistical or other measures of success. How much national security have we really acquired? Only time will tell. There are at least some rumblings that we may have underdone and underestimated the problem of transition to use in this area also.

I am afraid I haven't answered the question I started out to ask. The trend that I see now and which I think is the correct trend, and the desirable one, is the tendency for both systems, the modern and the old, as I have termed them, to evolve toward each other.

For example, one already sees much more concern in the defense, space, and atomic agencies with the problem of what is sometimes called "spin-off," the problem of translating developments brought forth by the work of these agencies into the industrial economy.

And even in the National Institutes of Health we see much more concern with the direct problems of medical care. A Congressional committee has recently prodded the National Science Foundation into exercising greater concern with problems of applied research.

What then are the directions which appear to be desirable for agriculture? I think certainly there is a real need and in fact one can see it already being met to some extent, for a more consciously opportunity-oriented approach to agricultural research. To some extent the opportunity-oriented approach is already represented by the pioneering laboratories of the Agriculture Department. One might describe this crudely as solutions looking for problems, rather than problems looking for solutions. It is customary to make fun sometimes of solutions looking for problems. Nevertheless, I would remind you that many of the biggest steps forward in the application of science have often come by this route.

Secondly, I think it is important for the Agriculture Department to make greater efforts to enlist the interest and participation of the wider scientific community in agricultural problems, the nonagricultural parts of universities, the fundamental science departments. To do this successfully involves not interpreting agricultural missions too narrowly. One has to accept a compromise in some cases between the quality of scientific effort and its apparent relevance to narrowly defined missions.

Third, I think, of importance, is the reformulation and restatement of agricultural missions in a way which is more challenging to the young scientist of today. There are not many young scientists who are challenged by improving the quality of peanut oil as such. But most of the young biologists I have talked to, even the very fundamentally oriented biologists, are passionately concerned about the world food crisis and believe and hope that fundamental biology will contribute most toward its solution.

Some believe rather naively that successful basic research will solve problems automatically if the results are just simply made available. To some extent we probably have to tolerate this naivety, provided we are not bemused by it.

We must find ways to mobilize efforts on more broadly defined and more functionally defined problems and support a higher proportion of research for which the application is uncertain or at least not obvious. I don't like to describe this as basic research, because in a way the term "basic research" has been abused and has come to mean useless research, at least in some people's minds. On the other hand, I am not suggesting that we should dismantle the tightly coupled system that we have developed in agricultural research over the years, the tight coupling to the social and economic objectives which it serves. Rather, I think we should try to strengthen these, but at the same time strike deeper roots into the general scientific community.

DR. MEHREN: My immediate reaction is whether we could, or should, try to change from the old to the new. Would you take that as your first question?

DR. BROOKS: I think that is a very good question, and I somewhat dodged it.

I think my answer would be to say no, one should not change, but one should try to nucleate some of the new within the old, while preserving some of the advantages of the old system.

I think to some extent this has been done already with the concept of the pioneering laboratories. But perhaps it hasn't been carried quite far enough.

DR. MEHREN: Who else has questions or observations?

DR. GALLER (Smithsonian Institution.): In nucleating, I wonder if there isn't a problem of tradition and almost an emotional resistance to the new in the sense that traditionally among many of the biologists there has been a hesitation to become involved in things that seem to have ultimate application or direct interest. Would you care to comment?

DR. BROOKS: Yes, although I agree that this is so, on the other hand I am not sure but what this is really a question of adjusting the meeting place to the right point. This is the point that I was really trying to make in that maybe one has to initially tolerate a little bit more irrelevance in the activities of biologists vis-a-vis agriculture than one has been willing to tolerate in the past. I should say apparent irrelevance.

DR. ALDRICH: I would like to pick up this particular point on the matter of apparent irrelevance. I have dealt within an institution that has made magnificent contributions to a variety of areas of every dimension of science. And I am aware that it is almost a defense mechanism on the part of some to point out how irrelevant what they are pursuing is to that which some of us in agriculture have thought most relevant. Yet I have not ever found these same people, once apprised of the meaningfulness or the potential meaningfulness of that which they have considered irrelevant, to really beam and adjust and want to identify with this thing.

And so I have felt that when you are not sure, build up a notion around you that it is beneath your dignity not to relate, but for the first one, as an administrator who comes along and says, "Friend, the world is waiting for what you are doing," that they don't get with it right now.

DR. MEHREN: That is well-stated. I think as a Californian I know what you are talking about.

DR. BRADY (Cornell): Your comments about the relative control over the old and the new by the Executive and the Legislative branches -- this is often used by those who would like to inject more of the new in the old as a reason why it is not and has not been done. That is, you have got to convince the Congress that you want to move in this direction, and this is not easy.

Do you have any advice to give to agricultural administrators as to how they might get a higher degree of control in the hand of the Executive compared to the Legislative?

DR. BROOKS: No, I am afraid we have other experts on that subject in the audience who are far better qualified than I to answer that question.

I might make one remark in answer to that question, and that is that, as Congressman Daddario said in his report on the NSF, nothing ever gets done if it is not suggested.

DR. MEHREN: And I hold an unverified hypothesis that it may be more difficult to exchange the old than to initiate the new, too.

DR. BYERLY: I would like to pursue one point raised with respect to projects. We have in agriculture totally in our system something like 16,000 research projects. Other agencies have rather more than we have.

You spoke of integration with the total institution, and I am thoroughly in support of that. Our present status is that 38 of our 53 experiment stations are in fact integrated with universities in the sense of supporting work with other colleges than the Department of Agriculture.

It is also true from the other standpoint there are 10,000 scientists in the experiment stations who receive about $30 million in grant support from agencies other than the Department of Agriculture. This is integration of a sort. It is project integration; it has its problems.

You spoke of opportunity. There is another word slightly like it -- opportunistic -- which accounts for some of the projects there endowed. While there may be no such thing as agricultural research, there is a focus on the problems of agriculture, on needs or opportunities, that is being eroded, we think, by this process.

Projects at best are declarations of intent. They name a principal investigator. The amount of work he does on a project for which a grant is made and the amount of work done by his superior graduate students are sometimes substantial. The correlation between what he said he is going to do on this project and what he turns out to be doing a year later is less than perfect. How do you face these problems of projects?

DR. BROOKS: There is someone in the audience who has a better answer than I.

DR. ALDRICH: I don't know that I have better answers. I think, Ted, that we must not mislead ourselves about the importance of the project title to the nature of the work that is done, because I think those engaged in agricultural research over the years have long since come to understand that unless the bank of fundamental knowledge which undergirds much of that which we subsequently apply in one way or another is continually built upon and replenished, we will be out of fuel and therefore there come forward projects which are identified in rather applied fashion in which it is apparent to all concerned who are knowledgeable that this man is really pushing a very fundamental area, and we accept this as part of the requirements.

And so to the outsider who would look at the list of projects that perhaps are pursued in one institution or another, it seems as though they are very much applied when the essence of the work is not there at all. I don't say this is right or wrong. I simply say this is a fact of life and how we have approached this need.

DR. RUTTAN (Minn.): First, I would like to suggest that the difference between the old and the new is not as great as it seems. It is partly a question of which organizations are going to receive continuous support. Because one simply doesn't build up research capacity and then allocate people around on the basis of individual projects.

And I am not sure that the Rand Corporation is really out-of-house research. So it is partly a question of which organizations are going

to receive somewhat near constant percentage allocations.

The second suggestion I have to make is another thing that we are talking about here -- the future of the university in research. It seems to me if one looks across the university to those parts of the university that engage in research programs, in contrast to hobby research, it is those parts of the university which have had some measure of continuous support that engage in research programs.

When I look at my colleagues in the College of Liberal Arts, for example, I see that the kind of research they are doing is a situation where, by hook or by crook, they get a grant and then they buy their time from the university. When that project is over, the continuity of the work is over.

I would like to see, as part of the new, some mechanism by which the rest of the university could have the kind of allocation of continuous research support that has been given to agriculture in the past.

DR. BROOKS: I think, as a matter of fact, that was one thing I failed to mention in connection with the new, and the two systems evolving towards each other. This is an evolution which is clearly taking place with respect to the new in university research. And it is the thrust, in fact, of all of the public policy statements that have been made in the last year. Some positive steps, for example, have been taken by the National Science Foundation to make at least some of their commitments on a longer term basis. I think we are evolving in that direction. Although I can see dangers and hazards in evolving too far in that direction. Also the project system has the great virtue of injecting a measure of flexibility and adaptability into the system, which is harder to achieve with an exclusively institutional approach.

DR. MEHREN: One more question.

DR. HAWKINS (Okla.): Speaking as freely and as frankly as we are doing today -- and it is delightful -- we are apt to open ourselves up to a bit of vulnerability here and there. And my good colleagues' reference to these damnable projects is a little bit like a campus reference to these damnable students. If it weren't for the students we might get something done.

I submit that the undergirding basic, continuing, hard money support of the agricultural experiment stations of the land-grant universities is by projects. There was a time when there was a pittance of $15,000 per year per State, not absolutely earmarked by projects. Even that time, Ted, has long since passed by. And the money nowadays is all projected in projects.

Projects have to be within a planned program to be meaningful. So I say further, there are planned programs within which projects effectuate research, properly manned by dedicated people.

MR. MEHREN: Do you wish to respond to that, sir?

DR. BROOKS: This is too complicated a question. I don't entirely disagree. I think there is a fundamental difference between projects as administered in agricultural research and projects administered in, say, NSF or NIH. The projects in agriculture are still essentially a way of dividing an institutional program.

DR. MEHREN: Looking at our project work from the other end as a member of a land-grant faculty, I must say that it never got in my way of doing what I wanted to do, mainly because I didn't always do exactly what the project title said, either.

Thank you very much, Dr. Brooks.

Now we will go to Dr. Phil Handler, from Duke University, who was born in New York City, and who obtained Master of Science and Doctor of Philosophy degrees in biochemistry at Illinois. He went to Duke as an instructor in 1939 and in 1950 became professor of the Department of Biochemistry, the same job he holds today. Fifteen years as chairman of that kind of a department must render a man fit for immediate entry into the kingdom of heaven.

He has done much work with the general science organizations in Washington on boards and in panel sessions of the National Science Foundation and the National Institutes of Health, Atomic Energy Commission, the Veterans Administration, and also on committees of the National Academy and the National Research Council.

He is a member of the Academy and recently has been made chairman of a committee on science and public policy to survey the opportunities and needs for research in the general areas of the life sciences.

Very much as in the case of Dr. Brooks, Dr. Handler accepted our invitation under somewhat trying circumstances, because he has a commitment of long standing in New York City tonight. He told us that it was not pressure, not arm-twisting, not even devotion to the cause of raising aloft the flame of human culture that led him to squeeze his schedule to come here, but rather we have infiltrated the field of biochemistry and hold a piece of Duke University.

Dr. Handler's first professional job was as a junior chemist in the regional soybean research laboratory at Urbana when he was taking graduate work at the University of Illinois. This perhaps is one of our best examples of how research programs -- good, bad, old or new -- assist in the training of scientific manpower and make it possible to have the man we wanted on our program.

Dr. Handler.

FUNDAMENTAL RESEARCH AND PROGRESS IN AGRICULTURE

By Philip Handler, James B. Duke
Professor Chairman, Department of Biochemistry, Duke University Medical Center

It is a far cry from the atmosphere of the present meeting to that when my assignment as a junior chemist at the Urbana Soybean Laboratory, USDA, was to improve the formulation of the recipe by which soybean protein could be converted into dashboards! Once again, soybeans are food, needed food. I have always appreciated that experience, which was mutually beneficial since it resulted in two patents that were later exploited on a substantial scale for the manufacture of paper sizings. At the same time I learned a good deal about the structure and chemistry of proteins and about the theory and practice of X-ray crystallography.

The all too familiar demographic projections suggest a world population of approximately 4 billion humans by 1975 and about 6 billion at the turn of the century, when the American population will be well over 300 million. Extrapolations beyond that point in time probably lack any certainty. Calculation of the consequence of continued logarithmic growth compounded at just under 2 percent per annum, is simple enough. But I hope that the validity of the promise is subject to challenge. Most of us find the notion of a world more than 2 or 3 times as populous as the present level unacceptable and seemingly unlikely. By this, we really mean that either the birth rate will go down or, necessarily, the death rate must go up. And indeed that is very good biology as can be attested by any student of overcrowded populations -- in the field or in the lab. We may fairly assume, I take it, that most of us share the conviction that population control is imperative if human civilization is to have a quality discernibly different from the brute animal existence. It will be too painful to think that the 2 billion years of biological evolution which culminates in man is nought but a grisly joke! But achieving that control is a long and difficult task; interposed are serious barriers of ignorance and of many cultures. Indeed, it is optimistic to consider that the educational campaign required can be effectively coupled with adequate techniques so that the population of the planet can be stabilized reasonably soon after the turn of the century.

Hence, we cannot escape the prospect that world agriculture must ready itself for the task of more than doubling its output over the next 35 years.

But double what? And how?

To answer these simple questions, one must first appraise how well we are currently doing. I was rather astonished to learn, in considering the data input for the Third World Food Survey of the FAO, how unreliable and uncertain are the estimates of the adequacy of world wide nutrition. It is agreed that huge numbers of people go to bed hungry every night. And it is a source of deep shame that some of them are Americans. It is further agreed that even larger numbers ingest a sufficient number of calories but are malnourished with respect to protein and vitamins. These are chronic problems which, from time to time, are brought into sharper focus by crises such as the present state of affairs in India. The overwhelming bulk of all such individuals live in tropical or subtropical areas but their numbers are highly uncertain.

In viewing the future of American agriculture, we commence from a position of great strength: a readily available surplus, and a ready reserve of 60 million acres in the soil bank; from the standpoint of the planet, we look to the future from a position of weakness and an awareness that world agriculture even now is insufficient to world need.

Part of the difficulty of making projections for agricultural policy tomorrow is the uncertainty with respect to what constitutes optimum human nutrition. One would think that, considering the diversity of climate, human genetic stocks, social and cultural patterns, soils, water supply, etc., somewhere on the planet there should be an area of both sufficient size and experience as to indicate what constitutes optimal human nutrition. But strangely this does not appear to be the case. If it does exist we have failed to recognize it. Perhaps we have failed to define it. Perhaps, if that is the best man can do, we have rejected it! Most of us are convinced that the only significant nutritional problem within our own country is that of surfeit. Obesity, hyperphagia, and the long-term consequences of diets abundant in saturated fatty acids appear to offer the most serious nutritional problems we can identify. But even at home, we have not successfully dissected the alleged effects of our hyper nutrition from the physiological consequences of our own way of life.

Abroad, one can readily identify the consequences of chronic under-nutrition, nutrition which is insufficient from the standpoint of calories, of proteins, or of vitamins. This has been seen in the increased stature of second and third generation Asiatics, Africans, and Europeans from the Mediterranean basin, when these are afforded the opportunity of eating western European or American diets. Across the tropical belts protein insufficiency is distinctly visible in its acute form as kwashiorkor. More subtly one sees somewhat impaired growth in children, somewhat abnormal concentrations of serum proteins in the blood of adults, a tendency to portal cirrhosis, endomyocardial fibrosis, and, it would seem, primary cancer of the liver. Elsewhere in the world, particularly in Malaysia -- which ironically, may well be the greenest part of the world -- one still sees vitamin A deficiency on a large scale.

Strangely, even now, there is disagreement concerning the nature and level of the protein in the diet required to prevent such developments. It is certain that the table of recommended allowances used to guide the planning of nutrition in this country is a table which recommends at least twice the real minimum of every component in the table, with the exception of calories. And it is amusing to watch dietitians regard it with the sanctity of a table of atomic weights!

If, then, one makes appropriate allowances, available estimates suggest that world caloric production is too low by a factor of about 10 or 15 percent. World protein production must be too low for the current population by at least 25 percent.

A major difficulty in making projections with respect to the appropriate forms of agriculture to be aggressively expanded in the period between now and the year 2000 is uncertainty of the extent to which one should insist on the presence of at least a modicum of animal protein in the diet in order to assure adequate nutrition.

A large fraction of the world's population lives on an essentially vegetable diet. But, statistically, this is the fraction of the population which is also both malnourished and undernourished, hence appraisal of the effects of vegetarianisms is hazardous. Whereas it has been repeatedly demonstrated that an appropriate mixture of vegetable proteins can supply a nutritionally adequate mixture of essential amino acids and bring with them an adequate mixture of vitamins, much of the world's population that, perforce, subsists exclusively on vegetable foods is also frequently restricted to only one or two major vegetables. At least in theory, their nutritional plight could be relieved by wholesale barter of vegetables for vegetables! Incidentally there has been no satisfactory assessment of the extent to which vegetarians are limited physiologically by the inadequate intake of vitamin B_{12} provided by such diets. Vegetable food faddists in the United States and Great Britain have been reported to develop pernicious anemia under these circumstances but the equivalent situation has not been reported on the scale on which one might have expected it to exist in tropical areas. This may be an overlooked complication of tropical sprue.

Insistence upon the provision of animal protein is, of course, highly expensive to the agricultural economy, since approximately 7 calories accumulated by photosynthesis are required to yield 1 calorie of animal food. That statement is misleading to the extent to which the animals in question are grazed on land that is not acceptable for other forms of agriculture, fed on the inedible parts of plants which are not acceptable of themselves as human food, or fed on waste and refuse from human consumption.

If, however, one adds to the purely biological considerations, civilized human considerations, one is led inevitably to the hope that at least a modest amount of animal food can be made available to all men at some time in the not too distant future. If we accept this as a reasonable goal -- and it is difficult for anyone who has dined at Airlie House to do otherwise -- then taking the figures for 1960 as a base, by the year 2000, total food production of all types must increase by approximately 150 percent, animal foods by over 200 percent with the bulk of that to be used in the underdeveloped nations where a goal of 500 percent increase is a not unreasonable aspiration. But I must repeat my earlier caveat: our knowledge of optimal human nutrition is primitive, and we badly require a rational basis for gross agricultural planning.

All of us have been exposed to projections descriptive of the total arable land area of the planet and the maximum food production of which it might be intrinsically capable with optimal farming practices. Various prophets have, at least to their satisfaction, calculated that this planet can sustain populations that vary from 50 to 150 billion humans. Clearly if we continue to behave as does a bacterial culture, but with a doubling time of 35 to 40 years instead of minutes, such figures would be attained all too soon. More realistically, however, let us assume that we can manage to stabilize the world's human population at something between 6 and 10 billion and that that can be accomplished early in the next millennium.

Having made this assumption, what are its implications for the magnitude and nature of agricultural productivity both at home and abroad?

In a general way that question really subsumes two subquestions, i.e., by what means can we improve the productivity of land currently under cultivation and how can we bring additional land usefully under cultivation?

With respect to the latter question, at least the arithmetic is fairly simple. The task is horrendous. Slightly less than one-tenth of the world's land area is currently in cultivation, and perhaps three times that area -- lands that are less favorable climatically, more rugged, or less fertile -- are in use as pasture. Thus, approximately one-fourth of the land area of the earth is being utilized for food production. Unfortunately, much of that land area has already been badly abused. In our own country, perhaps 300 million acres of cropland and rangeland have been essentially destroyed and another hundred million acres have been so badly damaged by erosion that they cannot be restored without enormous difficulty. For the country as a whole, of the approximately 9 inches of topsoil, on the average, when the country was born, about one-third has been washed away. The same process has occurred elsewhere in varying degree so that, as a consequence of man's own activities, with the passage of time, the areas of potential crop production have actually been reduced, and significantly. Hopefully, this process can be halted and all necessary

measures must be taken to do so both at home and abroad. What cannot be so readily halted is the retirement from production, currently at an annual rate of about 1 million acres, of the land which becomes suburb, shopping center, subdivision, or airport, etc. This accelerating and inexorable process includes some of our finest farmland.

The bulk of the world's agricultural production comes from areas that were originally prairie, steppe, or broadleaf forest under which a reasonably thick layer of organic material had previously accumulated. Most such areas are already under cultivation wherever the terrain permits, so that one cannot look forward to any major expansion of agriculture in such regions. To open new soil around the globe on a large scale will require using soil types that heretofore have not been extensively employed. In his book, "The Challenge of Man's Future," about 12 years ago, Harrison Brown quoted Salter to the effect that the most appropriate candidates are those regions where the soils have evolved mainly under coniferous forests and in relatively cool climates which have given rise to the "podsols," a thin layer of organic matter lying over a shallow layer of coarse, whitish, heavily leached material. Patently, the natural fertility of such soils is very low. Similarly the Tropics offer the lateric soils, which again consist of a thin layer of organic material over a very thick layer of heavily leached supporting material. These two soil types encompass approximately 10 and 20 percent of the land area of the earth, respectively, and only a trivial fraction thereof are currently under cultivation. The practical problem of using such soils for intensive agriculture is enormous. Improvements by conventional agricultural practice are of a temporary benefit and the problem of assuring stability and fertility of such soils, particularly the tropical variety, has yet to be solved. This is a great and serious challenge and one certainly worthy of enormous effort on the part of the research community. Please understand that the problems are not insurmountable -- they simply require easing. The crops of Finland and of the Philippine Islands are very largely grown on podsols and lateric soils, respectively, so that it can be done.

Only a fraction of this 10 billion acres should be put into production. Much of it should be held as productive forest; much of it is unavailable because of terrain and topography. But Salter suggested that of the order of 300 million acres of such northern soil and one billion acres of tropical soil could reasonably be expected to be placed under cultivation, if the appropriate problems of agricultural technology were solved. Salter has also estimated, using Finnish and Philippine experience as a base, the potential increased world productivity which might result. From his estimates, total cereal production could be increased 150 percent, roots and tubers could be doubled, sugar production increased 500 percent, production of fats and oils increased by 350 percent, production of fruits and vegetables by 170 percent, meat production could be increased by 30 percent, and milk production by 100 percent.

As noted also by Harrison Brown, and by numerous others, the productivity of at least 1 billion acres currently in production could be significantly increased, perhaps doubled, were sufficient water available. Hopefully, current reports of significant progress in weather modification, offering the potential of realization of man's dream of deliberate rainmaking, may obviate the necessity for enormous expansion of irrigation operations, since the latter are expensive and demand water that is available only with difficulty, if at all.

Several hundred million acres of desert are potentially productive if adequate water resources can be brought to bear. A considerable fraction of this area lies within the United States. Whether that possibility will be brought to fruition by water generated by rainmaking, brought in by pipeline from more northern regions, or pumped in from desalination plants, one cannot yet say. But, in any case, we are not prepared for that time! We know almost nothing of the potential ecology of our western deserts, were they to have the benefit of an adequate water supply. And before embarking on wholesale rainmaking or its equivalent, it behooves us to understand the consequences of such activities. It is not too soon, moreover, to prepare for that time by starting the search for appropriate genetic strains of those crop plants which will prove to be most suitable to such culture.

The sum of these activities would probably meet the emergency we have in view, doubling the world population by the turn of the century. But it is a large-scale process requiring an enormous expenditure of effort and of capital, an effort so great as to inhibit its early accomplishment. What, then, can we expect by application of science and technology to land already in production?

Whether we Americans accept the President's challenge and our own humanitarian instincts and attempt to use our agriculture to meet the food problems of the world, or whether we simply look forward to the growth of our own population, it behooves this nation to insure its agricultural productivity for the future. The era of food surpluses is just about over! The majority of the world's people today find most of their sustenance from only about a dozen species of plants -- the cereals: rice, wheat, and corn; the sugar plants: cane and beet; the root crops: potato, sweetpotato, and cassava; two legumes: the common bean and the soybean; and two tree crops: the coconut and the banana. (The banana, strictly speaking, is not a tree crop but rather a gigantic herbaceous perennial.) If the list be raised to 15 species one should then also include the peanut, sorghum, and barley.

These, together with only a few others, are the historical legacy of man's attempts to feed himself from the wild plants that have populated the earth. At least 3,000 species of plants have been tested over the years; more than 150 of these have at some time become articles of commerce. Those that are currently employed -- those which stand between mankind and starvation -- are those whose properties have proved to be most suitable to man's physiology and the cultural conditions of diverse corners of the earth. The magnitude of this dependence is in some ways appalling. For example, at least half of the world's people derive more than 60 percent of their energy from rice. Stated otherwise, more than 30 percent of all human energy comes from this one species -- the rice plant.

Ponder, then, the consequences of a rapidly spreading rice predator, or the rice equivalent of the chestnut or elm blight!

Using these basic crops, in our country we have witnessed striking agricultural advances within our own lifetime, the consequences of which are the enormously increased yield per acre and per agricultural worker of American economy. These achievements derive in part from an advancing mechanical technology and in part from the application of plant science. In addition to the growing appreciation, manufacture, and utilization of fertilizer, the most dramatic applications of plant science include the genetic principle of hybrid vigor, which has been most effective with respect to the improvement of corn yield but appears to be in the offing for wheat; increased knowledge of plant nutrition with the demonstration of the essential nature of micronutrients such as molybdenum, copper, and zinc; increased understanding of plant physiology, particularly of plant hormones which permitted the development of the hormone type of weedkillers; and the cooperative effort among entomologists, plant pathologists, and organic chemists which has permitted the rapid growth and spread of the use of diverse, organic insecticides and fungicides.

On this amount of science and its derived science one should be able to manage the food problems of the underdeveloped nations. They require no additional fundamental research. It should suffice to establish applied laboratories capable of doing the applied work that is required to match genetic strains of a food crop to local conditions for its culture. Beyond that, and even more important, is the absolute requirement for the necessary social arrangements -- long term credit, adequate fertilizer and seed stocks, roads and trucks, opportunity to market for cash the individual farmer's produced surplus. And as the Mexican experience has so well demonstrated, no one of these will suffice.

Although these developments have come to fruition in our own time, they have traded on the research of several decades and it is unlikely that the bounty of our soil will be significantly increased in the next several years beyond that which is already possible by the use of this group of techniques. Accordingly, it appears even more urgent that research be pursued with maximum vigor if our own agriculture is to meet the production goals for the next century, which one can see looming on the horizon.

New plant technology must rest on greater understanding of plant and soil science, on new chemistry, and on fundamental biological understanding. Progress in plant science has indeed been accelerating over the years since World War II, but it has not quite kept pace with biology generally. The disparity probably reflects the enormous assistance given to animal science and microbiology by the vigorous programs of the National Institutes of Health. If scientific agriculture is to flourish as we must hope, the science upon which it rests must flourish also and those responsible for our national program in agriculture must accept responsibility for support of research in biological and plant science generally. This is the philosophy that has been so effective at the National Institutes of Health, which has analogies in certain aspects of the programs of the Department of Defense and of the Atomic Energy Commission. It is the philosophy that must be adopted by the Department of Agriculture.

This cannot be done by restricting support to the in-house laboratories of the USDA -- no matter how liberal their research policies -- nor to the agriculture experiment stations at the land grant colleges. There must also be a vigorous program of support for the wellsprings of related science -- no matter where these may be. As a dividend, bonds are created between the USDA and first-rate academic scientists, the Nation over. And they may well prove to be agriculture's most precious resource!

What areas of research appear to be significant at this time and most likely to produce understanding which can be translated ultimately into useful agricultural practice? In seeking answers to this question I have borrowed freely from my advance copy of the Report on the Plant Sciences which has been prepared by a Subcommittee of the Committee on Science and Public Policy of the Academy. Allow me to list for you those I have chosen as opportune. This is but a sampler of areas of research which appear attractive to that committee together with several of my own favorite notions.

Fertile Areas of Research

1. Chemical weedkilling bids fair to eliminate one of the most ancient and back-breaking of man's agricultural labors. Research must continue to unravel the secrets of plant physiology generally in the hope that leads may be obtained which will open the way to specific

weedkillers, as well as others of general application. The other revelations only the future will ascertain.

2. The exciting work led by Sterling Hendricks at Beltsville has opened new vistas of understanding of the light-detecting systems of plants and the manner in which they operate to control the time of flowering. It seems entirely possible that pursuit of these mechanisms may yet make possible external control of the flowering process by chemical sprays.

3. Understanding of plant endocrinology -- the mode of action of the auxins, gibberellins, and kinetins -- is as yet quite primitive. Further studies of integrated plant endocrinology offer the opportunity of much more precise control of plant culture and opens unlimited vistas.

4. Cultivation of intact plants from single cells has been demonstrated in the laboratory and opens the possibility of revolutionary approaches to plant propagation and genetic manipulation. While such studies are pursued because of the light they may afford on the problem of cellular differentiation, it appears conceivable that they may ultimately prove to be of great practical utility.

Metabolic pathways, the chains of reactions whereby the plant synthesizes the materials of which it is composed from the materials of its environment, are being worked out in considerable detail. These and their genetic controls offer man the opportunity for a vast biosynthetic factory whose potential is presently limited largely by our own imaginations.

5. The ochre mutant of maize that has an unusual abundance of lysine has been much publicized. Undoubtedly, a strain of corn with an amino acid composition more closely approximating the balanced mixture required by man would be an enormous boon to mankind. For example, if used for the mealie pap of the Central and South African regions, it could prevent kwashiorkor in that large area. The available strain, as I understand it, grows poorly and whereas the protein is of good quality, the net yield of protein per acre is rather unimpressive. By proper selection, one should be able to capitalize on this finding and, ultimately, obtain a hybrid strain of high-yielding corn rich in the appropriate amino acids.

The same approach should systematically be pursued for other plant forms. All plants normally make all 20 amino acids. These are packaged in those proteins useful to the plant itself. Unfortunately, the seed forms of plants, the forms which man generally uses for his own nutrition, although obviously admirably suited to the reproduction of the plant are not equally admirably suited to our nutrition. The relative proportions of each of the proteins in the seed are determined by the function of regulator genes -- a term widely used in bacterial genetics these days, but invented by Barbara McClintock to describe phenomena observed in corn -- the high lysine corn is presumably the phenotypic expression of a mutant regulator gene. But the unusual amounts of the seed proteins that resulted are still compatible with the biologic function of the corn seed, while more suited to human nutritional wants. Accordingly, this line of investigation should be extended to include not only corn but the other basic crops on which life appears to depend. Even wheat could be significantly improved from this standpoint, whereas rice protein, which is present in small amount per 100 mixed calories, appears to be entirely adequate as a basis for human nutrition.

6. Although students of agriculture believe that it is unlikely that some major new food crop remains to be discovered, the fact remains that only a small fraction of the world's plants have been given serious consideration in this regard. There should be a continuing cataloging and examination of the possibilities for human nutrition, of the thousands of plant species that have hitherto not been regarded in this light. Indeed, it is about time to plan, on paper, the perfect food crop and breed toward it from the most appropriate starting material. The strains of corn, wheat, sorghum, rye, and tobacco, for example, presently under wide cultivation differ enormously from the wild types with which man started and, thus, are essentially an expression of this principle.

7. Although the majority of the world's principal food plants are of hybrid origin and their productiveness, at least in part, derives from their hybrid vigor or "heterosis," this phenomenon is incompletely understood and does not operate consistently in the desired fashion. Surely, the biology of heterosis is deserving of the most intensive attention.

8. In view of their enormous significance, each of the principal food crops warrants intensive study with respect to its nutrition, conditions of culture, and the continuing development of new strains whose physiology adapts them in superior fashion to specific conditions of soil, moisture, and climate.

9. The water economy of the plant reflects a balance between the availability of water at the root hairs and the functioning of the stomata of the leaves. It is already clear that application of materials which may plug a fraction of the stomata of the leaf does not seriously impair the leaf's physiology while reducing the water requirements of the plant. The potentials of this observation should be pursued both by seeking genetic strains with minimal requirements for water and by searching for agents that can alter stomatal physiology so as to affect a reduction in water requirement.

Clearly were such a program successful, it would open large areas of the earth to productive agriculture, areas which are marginal at present because of the limited water supply.

10. Only a small fraction of the total plant cover of the planet is potentially available as human food. We utilize seed parts in the main, whereas the leaf, the chemical factory of the plant, is rich in vitamins and minerals and its proteins are diverse in number and

composition. Surely this justifies a vigorous program searching for new technology whereby the components of the leaf, largely the protein, vitamins, and oils, can be made available as a supplement to the human dietary. Pirie has been active in this regard in the laboratory while proselyting this cause abroad. But he lacks company and a concerted effort in this regard.

11. In our age of abundance, it almost seems bad judgment to begin actively to consider the utilization of other biological forms for food. The production of food yeast has been attempted on several occasions, most noticeably in Jamaica; the culture of algae on a large scale has been discussed frequently but seldom attempted. Relatively little of the hundred thousand tons of wet kelp harvested annually is destined for nutritional use. Some aspects of algal cultivation on a large scale have been studied, some of the chemistry and technology of algal products is being explored, but surely the real developments must lie in the future. In our country the time is far off before we need contemplate developing the use of algae as primary food for man. But algae may very well hold the answer to how we shall manage to continue to enjoy something like our current bountiful supply of animal protein. It seems unlikely that there is any point, at this moment, in recommending a specific program with respect to the production of algae. But until that time, it would be well to embark on a serious program of basic studies on algal growth, development, nutrition, and photosynthesis.

12. We said earlier that it is thought that man has probably discovered the best plant sources to provide his major food energy requirements; at least those which we utilize have remained unchallenged since the dawn of recorded history. Although research continues to improve these, perhaps we may not find any new crop of major importance as food unless it be among the lower plants. But we have only just begun to recognize the chemical storehouse that is the plant kingdom. Surely continuing systematic investigation will reveal new oils, waxes, gums, new fibers, new drugs, and perhaps even new compounds for the control of parasites of plants themselves.

13. No creature has so altered the ecology of his surroundings as has man himself. But our understandings of the operation of ecosystems are rather dim. It behooves us continually to refine ecological understanding if we are to avert disaster as, by diverse procedures, we continue to control the environment.

14. The science of entomology has contributed much to agriculture. But for more than a generation, this science had become almost moribund. The use of chemical insecticides in the last several years has resulted in a small renaissance in this discipline. But surely the efforts to date have been insufficient; our approaches to insect and pest control generally must certainly be in their infancy. If more efficient and effective chemical weapons are to be designed for this arsenal, it can only be done in consequence of a much more intimate understanding of the anatomy, physiology, development, and behavior of the insect forms with which we are concerned. Yet modern chemical biology has not been applied on a significant scale to the understanding of insect life, largely because these forms do not lend themselves quite so readily to such studies. So it is hard to do. But it must be done.

When one considers the enormous destruction wrought annually by the predatory organisms that attack our major crops, and their importance to human life, it is appalling to recognize how little we understand of the life and times of these organisms. In retrospect, it seems that this field of endeavor has not flourished with the rest of biology, perhaps because of a kind of negative stimulus, the feeling that broad spectrum chemical pesticides would manage the situation anyhow, and, hence, that there is no need for improved understanding of the biology of these organisms. But nothing could be farther from the truth.

15. It is abundantly evident that no one chemical or small group of chemicals is going to provide sufficient control of insect pests. Even in the ideal situation, combinations of chemicals, each effective for quite different physiological reasons would be required to achieve anything like eradication of a given organism.

16. At this juncture I cannot refrain from noting my own frustration at the fact that it has been possible to breed and select strains of many crop plants that are specifically resistant to one or another attacking micro-organism, virus, or predator. But there can be no gene specific for resistance; such a gene must control some aspect of the intrinsic, working biology of the plant, the indirect consequence of which is resistance to an infection or predator when that chance arises. If we could identify that aspect of the plant's life we should be further along the highway of understanding, and, hence, useful control. At this moment, however, we have no insight into this problem.

17. The control of insect pests will be a continuing problem, which can only be managed by highly sophisticated biological approaches. These will include development of new chemicals with specific effects on the specific physiology of a specific insect and sufficient understanding of both the plant and its pests to determine selective methods of application. Moreover, these chemicals can only be used when it has been demonstrated that their employment does not generate an ecological situation into which some even less desirable predator may enter. As increasing areas of the earth are subject to such chemical control, in order that we may feed and clothe our human population, it will become increasingly important that the chemicals so utilized do not persist in the soil and are readily destroyed and detoxified, that they are not injurious either to the plant which they have designed to protect or to the other forms of life which we cherish.

As a biologist it is my own hope that with sufficient understanding we can minimize the

use of chemical pesticides. There have been a few glorious successes of this kind. These have taken such forms as, in the crudest situation, the draining of marshes to the introduction of specific parasites that have successfully fought off scale insects on citrus fruits, on apples, and on sugarcane, and predators that have limited the rabbits of Australia. In general, such possibilities have probably received less intensive investigation than they might have had, were chemical pesticides not available. In the end, we shall probably be forced to compromise between the hope of total eradication of a pest with the use of a chemical, which is itself noxious in one way or another, and settle for biological control which is unlikely to be complete but can reduce damage to an acceptable minimum. An increasing number of possibilities for such programs have suggested themselves over only a few years. The deliberate use of viruses specific for the pest organism has given spectacular control of the bollworm and cabbage looper in some instances. Other viruses have been effective against saw flies and caterpillars. Mark you'. Conception and demonstration of these possibilities is impossible without preliminary understanding of the native biology of the organism in question and the diseases to which it is ordinarily subject.

18. As noted by the President's Science Advisory Committee panel report on Cotton Insects, behavioral control of insects is a highly attractive possibility for the future. Inasmuch as the behavior patterns of insects are commonly steered or regulated by chemicals or other types of signals produced by the insects themselves, there is often the opportunity to direct the insects away from the crop plant which is their normal source of nutrition. The success of the USDA laboratory at Beltsville in isolating, identifying, and synthesizing the sex attractant of the gypsy moth is a landmark in the history of this approach. But there must be many other sensory cues which are species-specific and interference with these cues by broadcasting a sex or food attractant should provide specific and highly effective ways of misdirecting pests. At the same time, one obviates the problem of destruction of beneficial insects and other wildlife. Basic research on chemical communication among insects and on the effects of chemical stimuli on insect behavior should be a richly rewarding field and warrants generous support. Let us have a modern entomology!

19. Finally, I can only urge attention to wild, "way-out" ideas. The time is not today -- but tomorrow we shall learn to fertilize and farm offshore waters, rivers, and our large lakes; perhaps we shall manipulate the great upwellings -- or generate our own -- and thus decide where to "farm" the sea, "calling our own shots." The algal blooms that are now a great nuisance in our rivers should either be eliminated -- so the fish will survive -- or be harvested and become poultry, hog, or fish food. The dinoflagellates, now a great nuisance, can with imagination, also serve as a way to expand our animal protein supply. There are other photosynthetic organisms which, per square foot or per acre, are considerably more efficient as light energy traps and synthesizing machines than are our traditional crops. How can we use them? No ideas should be rejected simply because they are unconventional -- let us try them all.

It will be evident by now that much must be done if we are to provide the scientific underpinning of a modern agricultural technology. The sophistication of that technology to date is the platform on which rests the remarkable affluence and sense of well being of American society as it enters the age of the scientific revolution. It is that technology which has made it possible for one man to feed 20 of his fellows, freeing those fellows to develop still other technologies or to explore beckoning avenues of the spirit and of the mind. If it be at all possible, we must offer that same prospect to our children's children, in our own land and in all the far corners of the earth.

DR. MEHREN: Thank you, Dr. Handler.

You didn't make any reference, either in the suggested program or in blocking out of fruitful research areas, to the possibilities of synthetic food generally, or to synthetic supplementation in present foods. Why did you leave those two out?

DR. HANDLER: Probably because I am a biologist more than a chemist. But I think the scale of the operation which you suggest is prodigious, and this is the real difficulty.

Large scale use of synthetic vitamins is feasible and practical. We do this all the time -- we enrich all of our bread. But when you consider synthetic lysine--lysine, tryptophane and methionine on the scale required to upgrade the protein intake of billions of people--that is a vast effort. I suspect that if the funds required were put into agriculture, they would be much better invested and you would get a much higher return in terms of our ability to feed people.

DR. GALLER (Smithsonian Institution): Dr. Handler, do you visualize an enlarged agricultural role for some of our fresh water and coastal resources?

DR. HANDLER: Yes. I restricted myself strictly to plant science in a primitive, pure sense. Undoubtedly, we are going to use the offshore sea waters and fresh waters more extensively. We are going to learn to fertilize bays, estuaries, and salt ponds. But we must wait until William McElroy and his colleagues can tell us what is responsible for upwellings, and can give us more understanding of what determines which areas of the sea are productive and which are not. The Mediterranean is a desert and we don't know quite why. When we have more understanding, we will know how to use this resource for food production on a vast scale, undoubtedly. Most particularly do I hope that we will find means to use the world's fish catch for production of a high protein meal that can be used as a supplement to the dietaries of children in the tropical areas who, otherwise, must subsist and grow on diets composed of only a few staple vegetable crops.

DR. BROWN (California Institute of Technology): Dr. Handler, I was quite interested in your expressed worry that you were not able to define, about the dependence of such a large portion of humanity on rice. I suspect it is because you are a biologist and you have seen in the course of evolution what happens when one has over-specialization.

DR. HANDLER: Exactly. Just imagine the chestnut blight becoming a rice blight and crossing the planet.

DR. BROWN: We, of course, have had experience with over-specialization in the Irish potato famine.

But getting back to your all too brief discussion of the potentialities of microbiology, I happen to feel myself that the potentialities really are enormous. But one of our problems is that we don't need these things ourselves, yet we have the methods for finding what the technology might be. It really requires a teaming up of the microbiologist on the one hand and the food biologist on the other and the social scientist studying behavior food patterns as well. I really believe there is an enormous area here, but it has to be done again just like agricultural research. It has to be done indigenously; it has to be done where the material is going to be consumed.

I have been quite impressed more recently and particularly following quite a long discussion with Carol Wolfson, that the recent work on the culture of bacteria in petroleum has great potential. Although this is clearly not what you would call a long-term solution to the problem, nevertheless it does, I believe, offer considerable promise for the alleviation at quite low cost of a serious problem.

Here again I feel that all too little work is going on in these areas. Again, it is going to involve the food technologist who can fabricate the raw material into foods which are palatable to the local people.

I have a feeling that when we talk about basic research and applied research for an alleviation of the food situation, that we really have to start thinking seriously and working seriously in way-out ways over and above the more conventional approaches to agriculture.

DR. HANDLER: Certainly with respect to feeding the rest of the world, there is no doubt of what you are saying. You said better than I did the message that I hoped to convey when I mentioned this area rather briefly in passing, and that is that what we have to do now is help learn how to do it.

In the foreseeable future we are not likely to use new sources ourselves as food for Americans for some time. But I think these can be put to work abroad fairly soon effectively, provided one learns how to do it reasonably economically. And the economics, it seems to me, are easily self-justifying.

DR. MC ELROY: I question even in this country, economically, if we don't need to know more about the mechanism of farming estuaries. Rather, the donor flagellate production which we can move with fertilization with tremendous quantities as animal food, not for human consumption but as animal food.

I would made a speculation that if adequate research and know-how were put in this direction that you might have competing food for animal production right here. Not just fish growth, but food for animals in general. I think we don't know enough about it yet.

It already has been demonstrated that you can do this with fish farms quite adequately and make money at it. The thing that sort of intrigues me is that India can also do this with shrimp, and they export $11 million worth of shrimp, more or less, every year. Maybe they would get more in return for it by getting a big price in the United States and maybe buying more rice. I don't know what the answer is.

It seems to me this is the type of thing that one could stimulate even more so in other foreign countries -- using this type of additional farming of rice paddies and other types where you have a lot of water.

DR. MEHREN: I have a question of an immediate 1966 significance and of an immediate applied nature. If we are to mitigate the magnitude of death from hunger, say in India and Pakistan, this year, we have very limited mechanisms whereby we can do that. Really we have one, and only one, and that is wheat. With India and Pakistan getting roughly two-thirds of our food aid in the past, as I recall they got 61 calories per day on the average, which isn't much. So it is very obvious that we can't get enough wheat into people to eat to give them what is roughly called a balanced diet. What if anything can we do in bucking up what wheat we do have to ship abroad from the viewpoint of nutrition -- whatever nutrition is -- that would be better than just straight wheat?

DR. HANDLER: This year, nothing. We can't get into production to handle the 1966 problem on any scale. It will make the wheat

one look larger by that scale, starting now. The production problems are very large.

DR. SEITZ: Getting ship bottoms is a problem.

DR. HANDLER: Then you can't unload them on the other side. If you do, you don't have trucks. If you have trucks, you don't have roads. But I do wish to reemphasize the desirability of vigorously pushing the utilization of fish and seafood.

DR. MEHREN: Dr. Brown?

DR. BROWN: There is one other area where I believe that the North American technological community could play a substantial role from the point of expanding new areas of agriculture of a sort. And that would be to develop techniques, really, again sort of way-out techniques, for utilizing the very difficult lands in the tropics, such as in the Amazon basin.

I have a feeling that with modern engineering practices it might be possible to devise techniques -- there is plenty of water -- for really large scale fish farming, for example. Techniques of that sort which have been used in other areas, but where in these other areas we have not had to apply the engineering. In the Amazon basin one would have to apply a great deal of engineering, and this is one thing we are good at.

DR. VORIS: I have a point about our ignorance on optimum need in human nutrition and the inaccuracy or unpreciseness of the recommended dietary allowances. These were not designed to be minimum requirements for human beings; they are used for planning procurement of food supplies and in that connection they have to be used in conjunction with tables of food composition which have a much lesser degree of confidence than the recommended allowances themselves.

DR. HANDLER: I certainly agree.

DR. VORIS: We have developed pretty much of an optimum nutrition in terms of the productivity of animals which are fed for a given purpose.

DR. HANDLER: I don't know how much fat world agriculture should produce because I don't know how much fat human beings should eat. This is the problem which I said is really very difficult.

DR. VORIS: I grant you that. But I do think that in terms of the applications, social applications, that the recommended dietary allowances for the developing of nutrition programs should be for feeding people.

DR. HANDLER: I don't challenge that the "recommended allowances" are goals for planning.

DR. VORIS: It is the best we can do at the moment. Particularly in terms of fat, the optimum relationship of fat and carbohydrate.

DR. HANDLER: Or how much calcium we ought to eat. We don't really know.

DR. VORIS: Calcium is not important in nutrition. It is energy and protein that are of primary concern.

DR. MC ELROY: I am surprised you didn't mention the kind of research we should be doing. If I thought I was going to starve to death, I would love to have a chemical to cut down my metabolic rate to practically zero so I could hibernate.

DR. HANDLER: I don't consider that an acceptable solution. Deep freeze might work, but I really don't think of that as an acceptable solution. It is acceptable, but for a different purpose.

DR. MEHREN: Why don't we limit this to one more question, because there is a lunch hour coming. Dr. Byerly?

DR. BYERLY: I would like to make my question apply to agriculture and the possibility of joint effort. In one field -- the problem of pollution of our lakes and streams -- we must of necessity address ourselves to this problem. Can we, incidental to that, learn something about the usefulness of the algae which, by their exhaustion of oxygen, kill our streams and lakes? Perhaps if you don't like carp, at least see if they will clean up the streams.

DR. ALDRICH: I was going to comment that this matter of the use of algae for cattle feed has a multiplier effect inasmuch as in cleaning up water that humans have used, it is one of the stages by which we can reduce the electrolyte content of water and at the same time nourish algae which in turn can be used to feed cattle. This is one of the stages we are exploring with water re-use efforts.

DR. MEHREN: Dr. Seitz, Dr. Brooks, Dr. Handler, our thanks. My thanks to all of you.

(Whereupon, at 12:26 p.m., the Conference was recessed to reconvene at 1:30 p.m. of the same day.)

AFTERNOON SESSION (1:30 p.m.)

DR. SEITZ: It is our very great privilege this afternoon to hear from Secretary Freeman. As all of you know, he received his appointment as Secretary from President Kennedy in 1961. He is a native Minnesotan, closely identified with that State. In the Department of Agriculture he has been identified with much progress in the face of very great challenges.

In his own State he served for three successive terms as Governor before coming to Washington as Secretary. I will now call on him.

AGRICULTURE'S MISSIONS--AT HOME AND ABROAD

By Orville L. Freeman, Secretary of Agriculture

When a scientist named Justus von Liebig was just 14 years old, he blew the roof off a drug store in Heppenheim, Germany.

This explosion, the result of the boy's secret experiments with fulminate of mercury, discouraged the druggist from keeping him on as an apprentice. But being fired didn't destroy young von Liebig's interest in chemistry and plant life. He continued his studies, his experiments.

They led him to the discovery of phosphate and potash in the ashes of burned plants, and ammonia in their vapors. He put all three into barren ground, and made it a wonder of fertility.

"There will be a time," he said, "when the fields will be fed with substances produced by chemical industries, and containing the substances indispensable for plants."

History has treated few prophets more kindly.

Justus von Liebig was born in 1803, and when he died at the age of 70, the United States Department of Agriculture was only 11 years old--but already deeply involved in basic and applied research.

I know of no legend which claims USDA researchers began by blowing the roof off a grocery store, a dairy barn, a grain bin or packing plant.

They have, however, triggered many of the explosions which mark revolutionary changes in the physical environment, the food and fiber production and utilization patterns, and the social and economic aspects of American life.

I welcome the opportunity to discuss with leaders of the science community the role of research in the missions of the Department of Agriculture--but first:

Let me express my very deep gratitude to Dr. Seitz and the National Academy of Science for joining the Department in sponsoring this Symposium on Research In Agriculture, and...

Thank all of you for your participation.

The Department of Agriculture and its research services are honored by your presence, inspired by your interest, enriched by your cooperation.

I am not, as you know, a scientist--unless it can be held that practical politics and government administration hold a place on the fringe, if not actually in the field, of science.

I can measure the B.t.u.'s of a public issue without a thermometer, but I cannot regulate the flame of a bunsen burner with any degree of skill.

I can analyze the generation of turmoil in a political party convention far better than that resulting from combinations of chemicals in a test tube.

I can read between the lines of a Gallup Poll, but not between specimens under a microscope.

And I react more quickly to the theory of votability than to the theory of relativity.

So allow me, then, to paraphrase Voltaire:

I may not fully understand how you do what you do, but I shall always be grateful for the fact you do it--and do it well.

For without research the politician, the public official, would function constantly in a vacuum....because it is research that both asks and answers the questions related to public policy and program determinations.

Does it need doing? Can it be done? If it can be accomplished in a variety of ways, which method should have priority? How can it be kept in balance with other policies and programs? What type of administrative structure will be required? How is it related to the various States, to other agencies of Federal government, to private industries and institutions? What will happen as a result of the action or actions taken?

I have found these questions and the search for answers applicable across the vast range of the Department of Agriculture's operations--

whether it be in finding, as USDA did, a faster and more economical method of producing penicillin....

encouraging an environmental adjustment that will solve, in major degree, the population pressures of cities and the underutilization of both natural and people resources along the countryside....

encouraging, and maintaining, abundant production of food and fiber while moving toward the economic goals of parity of income opportunity for farm families and fair prices for consumers....

protecting food purity and quality, developing new products and new and better distribution, marketing and processing systems....

cooperating in the public welfare field with direct distribution of foods to needy families, participation in school milk and lunch programs, and food stamps....

protecting, developing and expanding the multiple-use of natural resources on public and private lands....and,

helping the food-deficit Nations of the Free World take the lead in the war of liberation from hunger and malnutrition through the improvement of their own agricultural production plants.

I would hesitate, without strong and versatile research arms, to attempt to carry out these and other missions that the people, the Congress and the President have assigned--and will continue assigning--to the Department of Agriculture.

As I pointed out earlier, the Department of Agriculture was engaged in research long before any of us was born -- and for 99 years before I became its Secretary. Consequently, I can point to its research performance with pride without being self-serving.

The first major support provided to research by government was in the field of agriculture. And as recently as 1940, when the Federal government began broadening its research and development support to a total of $74 million, agriculture research received two-fifths of the outlay.

A quarter of a century later, in fiscal 1965, Federal support for agricultural research alone exceeded the entire 1940 expenditure -- amounting to $231 million. But instead of two-fifths of the total research and development budget, Agriculture has 1.5 percent of it. By that time Defense was being awarded $7 billion...NASA $4.9 billion...the Atomic Energy Commission $1.5 billion...and HEW $813 million.

I do not cite those figures to call attention to the fact Agriculture's share of research and development appropriations has declined in relationship to the total Federal expenditure -- but rather to emphasize that, as a pioneer in the field, Agriculture perhaps deserves some credit for creating a favorable climate for expanded governmental interest and investment in research. In other words, agricultural research -- since 1862 -- had been demonstrating to the people and the Congress they were getting something for their research money.

Our government has not only used the Department of Agriculture as a trail-blazer in research, but in tieing research to education through the Land-Grant Colleges, and then carrying knowledge to the rural community through Extension Services....thus providing, in fact, a working model for the transition of science into technology.

Out of this combination of basic and applied research, of education and extension, has come in substantial measure the greatest food and fiber production plant the world has ever known....great in the skills and judgements of its operators....great in the volume and quality of its output....great in its potential for perpetuating the era of abundance.

American agricultural development is, indeed, one of the miracles of this century.

It was when we freed more and more people from the task of producing food that we made our human resources increasingly available for an ever-widening range of activity in industry, commerce, education, science and culture.

It was when we began making an adequate supply of food an ever-decreasing drain on family incomes that Americans could increase their investments in living well beyond buying their daily bread.

Look at what has happened:

Today one farm worker provides food and fiber for 35 other persons. A century ago he met the needs of just five others, and as recently as 1950 only 15.

In 1950 American families were spending about 25 percent of their take-home incomes for food. A decade later it was 20 percent. In 1965 it was an all-time low of 18.5 percent. Continued advances in production and marketing efficiencies, and in consumer earnings, are expected to bring further cuts in family food outlays -- to about 17 percent of take-home pay in 1970, 15 or 16 percent in 1975.

Meanwhile, average realized net income per farm reached a record high in 1965 and our farm families are well on their way to parity of income opportunity with their urban neighbors -- a development which, in turn, improves the tone of the total economy.

Important as it is internally, this production miracle is even more vital this year -- and in the years ahead -- as an export item while the world accelerates mobilization for an all-out war on malnutrition, hunger....even famine...in its widespread food-deficit sectors.

We have the knowledge accumulated through research and its application, we have the experience in grass-roots educational programs, and we have the food....all the weapons essential for leadership in helping less-developed Nations help themselves achieve the ability to grow -- and to buy -- enough food for their families.

This is a task that has captured the hearts and the imaginations of our people. It was blueprinted by President Johnson in his inspiring...yet studied and realistic...Food for Freedom Message to the Congress. And now legislation in support of the Food for Freedom program is being hammered out by the Committees of Congress.

A few weeks ago I visited the fighting front -- and the farm front -- of South Vietnam. I saw efforts to protect freedom, and to produce food, going on side by side. Agriculture is the key to freedom's victory in Vietnam. Fertilizer is just as important as bullets in the winning of that war.

We must fight in Vietnam. And we shall fight until its people have the right to determine in their own way the type of government under which they shall work and live. Yet military wars come to an end. The battle against malnutrition, hunger, and related mental and physical health hazards is endless -- new victory is demanded every year.

There can be no great love of country, nor firm loyalty to its institutions, in a human heart that beats above an always-empty stomach.

There can be no genuine economic growth future in a Nation over-populated with children whose bodies are thinned, eyes glazed, minds dulled by malnutrition. And even though there are -- at least in the judgement of those not their parents -- too many of them...these children are in our world, now, and the world must, as Pope Paul pleaded, find them a place at the table. Population control cannot be retroactive.

We can and we shall use our food, or productive resources, and our know-how to help the farm families and the agribusiness structures in those developing Nations where production is now losing the race with need.

But our food can only support -- not substitute for -- their own efforts.

A successful war against hunger and want has its roots in research and education. Unless our food supports research and education aimed at making the agricultures of developing Nations grow and support their total economic development, history will rule it wasted.

The Indian boy who eats American wheat today still must eat 10 years from now -- and provide food, at that time, for his own children.

Over a span of a hundred years, agricultural research has asked many questions, answered many, and in the process has raised more questions demanding more answers....because that is the inevitable -- and usually desirable -- result of the research cycle. Now these questions must be asked, and answered, in increasing volume around the world if it is to adequately feed itself -- asked and answered not only by the scholars and scientists of agriculture, but of the entire research and education structure of our society.

During the past quarter-hour I have described the Department of Agriculture as an agency of many missions.....

we are a production instrument...an economic innovator and stabilizer...a custodian of publicly owned natural resources and a cooperative planner in those privately owned.....

we are a teacher...a communications media...a regulatory system....a welfare unit....a rural development promoter....an arm of foreign policy implementation.....

But we are not an island. We are a part of the main. And in relationship to every area of science and education we are dependent -- and seek to be dependable.

That's exactly why we asked Dr. Seitz and the National Academy of Science to help us bring outstanding representatives of the science community to the same place at the same time.

And that's why, as I enter and leave the Administration Building of the Department of Agriculture each day, I see exhibits in the patio not only of research covering food and fiber, but exhibits of the Corps of Engineers related to buildings that will some day be constructed on the moon....and exhibits of the Bureau of Ships related to making submarines of glass.

Within USDA itself the competition for men and women and dollars in the various units of research is rugged, and fixing priorities in assignments and objectives isn't easy. Reconciliation, cooperation, coordination... meshing the parts to end up with a meaningful whole....demand much of each of us at the Department's policy-making level.

This intra-department situation is applicable to the entire range of government-sponsored research and development. It is mandatory, in the public interest, that we constantly develop new bases for coordination of research and the pooling of knowledge among Federal agencies and, hopefully, among other government and private agencies as well.

If this Symposium achieves nothing more than a demonstration of the Department of Agriculture's appreciation for the strength that lies in the creation of broadened understanding, and the promotion of concerted endeavor, we shall consider it most worthwhile.

We are anxious to earn, and to hold, full partnership in the basic and applied research community so that we may contribute to it... receive from it....with the purpose of moving more quickly toward the goal all of us share --

improving opportunities for all people, everywhere, to achieve maximum quality in every facet of their lives.

SECRETARY FREEMAN: We have about 60 million acres of land in reserve in this country. We could produce about 60 million more tons of grain, and grain is the best unit of measurement to analyze the situation in these countries. We have made some very careful studies in that regard. First of all, as matters stand today we couldn't possibly find a place for 60 million more tons of grain. We don't have the storage, we don't have the boxcars, we don't have the ships, we don't have the port facilities, let alone the ability of the less developed countries to receive or to distribute grain. It is literally a physical impossibility.

We have been steadily moving up the use of our food. Today we reach 100 million people, more or less, in over 100 countries. American food supports the school lunch programs for 70 million children around the world. That is almost four times as many as we help at home. American food helps to finance projects abroad ranging from the financing and grub staking of pioneers who open new lands to educating farmers to diversify their operations, to building schools and

roads and hospitals, and to many kinds of research.

With the passage -- and I am confident it will pass -- of the Food for Freedom legislation the President has sent to the Congress, we will be able to produce what we need rather than to distribute what we have. The amount that will be used and the effectiveness with which it can be used will increase, I think, significantly in the years immediately ahead. We have learned a good deal. But no one ought to be so misguided as to think that we can distribute effectively all that we are able to produce. As I say, some day perhaps that can be done. But it cannot be done now.

In seeking to use our production more effectively, which I am convinced the people of this Nation would support, the difficulties must be kept in mind. We need to recognize that no nation wants to be dependent on us for food. I have yet to talk to a political leader of any country who wants to receive food. He recognizes that it has a debilitating influence on his people. He wants his nation to stand on its own feet. As such, everyone I have talked to has felt that this is, they hope, a temporary matter.

In the use of our food we must be conscious that it ought to be a stimulus and not a crutch. In some places around the world, I am afraid, it has been a crutch.

So our objective now is to build the necessary intrastructures, to use our food products more effectively, to recognize that our basic goal is to strengthen and help each country to increase its own production. Not only is this the right thing to do, but it is the only way we can possibly win this war.

By about 1984 the total food capacity of the free western world, as great as it is, would not meet the demand which would exist if the current increase of productivity is not significantly stepped up in the less developed countries.

In other words, unless the receiving countries do an enormously better job, it will mean that, despite our efforts of the last five years, instead of making progress we have fallen behind. In one way we can be grimly pessimistic about this because we have distributed about $15 million worth of food, and 160 million tons, as I recall, we are no further advanced than when we started. On a per capita food base the world is no further along than it was when we started. The principal reason for this, is the tremendous increase in population. But this underscores the fact that research and careful review have revealed that down the road "X" number of years -- which we now estimate at about 20 -- the capacity of the western world to feed the less developed nations, if they do not increase their current rate of progress, will no longer exist. And then Malthus would indeed be right and we would have world famine to face.

So this, then, becomes a very, very real challenge. I want to say that it is not one in which I feel pessimism. Quite the contrary. For a number of reasons I feel optimism in connection with it because of the President's Message, because of the country's response, and because I think that in most developing countries -- including those two with which I have been working most closely in the last two months: India and Viet Nam -- there is a real demand by the cultivators for the tools of modern agriculture. Fertilizer today in both Viet Nam and India is bringing twice as much on the black market as it is under list price. And this is indeed a healthy sign that the farmer is ready to improve his farming methods.

Another thing we have learned, too, is that part of the process of getting these new inputs into use is to take a look at that person who is going to use them, rather than at that project or that system or that method. By that I mean perhaps the most important component and element in getting acceptance and use of the new technology is the cost-price relationship. And the farmer -- I don't care whether he can read or not -- will learn quickly. If he will make more money by using fertilizer, he will use it. As a matter of fact we must acknowledge that the feed and fertilizer salesmen, starting about 1935, who peddled the back roads of this country with hybrid corn and with the first use of fertilizer, made as great a contribution to getting those inputs used as the programs that we have followed -- and I don't belittle them for one moment -- in our extension programs, our publications, and all our educational efforts.

This business of getting down to the people to find out what makes them tick is important. In those nations with which I have been fairly close in the last couple of months, where demand outruns the supply, this is the most encouraging sign of all.

Thank you very much.

MR. EMERSON: Mr. Secretary, in your visits to India and Viet Nam have you found a government structure that could carry out these programs effectively? Or will this have to be built?

SECRETARY FREEMAN: A partial structure. You find some very dedicated, very able people in most areas in each of these countries. But as I am sure you have found, it is awfully thin. One of the areas, frankly, in which we hope we have made some progress, in Viet Nam, concerns drafting men who are highly skilled.

I talked with the Prime Minister about it. His response was an interesting one. I thought it was a timely one. He said when the current government came into power, the draft was an instrument of favoritism and there was no pattern of uniformity. So they quickly determined that everyone, regardless of who he was, where he was, or what he did, would be subjected to the draft, and they were. He said now "we have this cleaned up and we realize the problem."

I don't know what they have done, but he indicated to me the possibility that they would

draft people and assign them to their specialty fields while they were in the military service.

I found some Vietnamese agriculturists that I thought were very good. I had 10 top experts in various fields of agriculture with me. Each reported some outstanding and very effective people. But the problem of implementation in helping some of these people to carry through requires a lot of push, a lot of help, and we need some more bodies.

I need some recruiting right now. If anybody knows some agriculturists who are good, able, and willing to go to Viet Nam -- I an not an AID agency but you can talk to Al Moseman, and I think Dave Bell would say "God bless you" -- we need them and want them out there.

DR. WENK: Mr. Secretary, you have indicated that the Department is no newcomer in this field of international affairs, and I think most of us are aware of the implications of the President's program. Do you feel that the statutory authority of the Department will need major changes in order to permit you to occupy a more global role?

SECRETARY FREEMAN: No. In the sense that we should be strongly fortified legally in being able to shape American domestic agricultural production, to produce the things that we need, and not depend on the happenstance of surpluses -- yes. This is involved in the companion bill with PL-480 for a security reserve program. So we would have reserves which as a matter of national interest are critical. Under current law, if I followed the letter of the law strictly, we would dispose of everything we have and sweep the cupboard bare. We have not done that. That very mandate has been cancelled by some other laws in relation to specific commodities. But this would clear that up. It would take away the requirement of surplus disposal; it would put us on much firmer ground up and down the line.

In terms of the economic development and technical assistance part of this, the legal responsibility runs to the AID agency and not the Department of Agriculture. But our working relationship has been one that has been expanding rather rapidly through the contract method primarily. With this new kind of forward economic planning, food and food use will be an integral part of the forward planning and of the evaluation of the results. Dave Bell and myself are busily occupied now in working out the mechanics and machinery for a small consultative effort at all levels, including the early forward planning, as well as a review of the net results. So this is a kind of a shared responsibility in this area with a strict legal responsibility and appropriation for technical assistance as such running to the AID agency rather than the Department of Agriculture.

DR. HAWKINS: Mr. Secretary, you have made quantitative estimates and to a certain degree predict projection ahead quantitatively. Do you care to estimate any more specifically than you have done thus far whether we have about attained for the immediate future -- this meaning the next two years -- maximum provisions of food supplies, primarily for relief purposes, not for commercial export, or whether we are apt to increase it another 50 percent -- our shipping and dock facilities in this country and on the receiving end at the other end are limitations -- are we about to the maximum now and not likely to change materially in the next two years? What is your estimate, if you care to estimate?

SECRETARY FREEMAN: We will be increasing the volume, I think, quite significantly. There are two parts to this. Pure relief feeding: Under current law this is under Title III, the distribution which takes place primarily by the voluntary agencies, church groups, Red Cross, CARE and others. We are prepared and will be prepared to increase those amounts. The only limit really now and in the future will be their capacity to distribute most of this. Wheat has been available -- no problem. Oil has been generally available -- no problem. A great deal of work is being done. One of your colleagues in the field of science I took out of the laboratory down at New Orleans and gave him an assignment as special expediter in this whole area of research and implementation on nutrition and food enrichment, and that is Aaron Altschul. He has written a number of books on this. Most of you know him individually or professionally.

There is a great deal going. We are mobilizing the private sector of the economy and pinpointing the kind of research that needs to be done on food enrichment and on protein enrichment.

I don't mean to deviate from the question, but it opens up an interesting field that I am sure you are interested in. There aren't enough animal proteins and they are too expensive. We have to get down into the vegetable proteins. This is primarily in the oils and vegetable proteins. And how they can be enriched in combinations that will be, (a), acceptable and edible, and will be used; and (b), how they can be efficiently and effectively produced. Also, how we can prevent the great waste that is taking place today? For example, soybeans. We feed animals and we live on animal protein. It is being used as fertilizer throughout the world rather than as food. The crushings left from cotton seeds and soybeans, I am told, are equal to the need. If many of the countries today use what they are throwing away, you would be over the hump on the protein deficit.

This is a long-term project. We have to know where it is and what it is and how to go about it. We are trying to get private industry interested in this. A quick example of some success is Quaker Oats. In Latin America, where they are commercially selling this product which is highly protein enriched, they are able to carry out a commercial operation. I think we will get quicker and better distribution that way than any other. We are tapping

that one and really ready to take off and go. We continue to serve about as much as can be used by the involved agencies.

To answer the question another way, what about the commodities and their availabilities? Here is where we have been subject to some fluctuations and difficulty on forward planning in the past. I mention dairy and dry milk solids of the past where we have had extremes of shortage and then long supply. Now we will be able to be in position where we can have an adequate supply and can plan with some assurance. At the moment I am in the middle of that one. We are facing some shortages. We have tight supply in dairy and dried milk. We have relatively tight supply in soybeans. Vegetable oils are in pretty good shape. We have more than we know what to do with in feed grains. And we are getting into a fairly tight supply situation in wheat. If we have another year of drought and have the heavy demand that we are getting from India now, we could be in some short supply position wheat-wise.

If we do, we will face down the road here, in a couple of months. Should we or should we not increase our allotments, our acreage of wheat production? But it is like every other problem, you generalize about it; that is one way. Then you get down to cases about it and see what are the elements that make it up, and there are many elements that make this one up.

I would say that the volume will go up half a billion dollars in the next 18 months on a yearly basis. Then how fast we use food will depend upon how effectively it can be used to stimulate that economy and what those countries are prepared to do themselves. We have to meet relief needs. We can't let people starve, and I don't think we are going to. By the same token we can't just spread this with a lavish hand all over the world because it will do more harm than good.

When the planning commission in a country with highly limited resources gets down to figuring up their plan, with all the local political forces, and decides where they are going to build a highway or dam, or where they are going to put foreign exchange to buy fertilizer--that is a tough one. In most of the countries they don't buy fertilizer. They build a public building--something they can look at--or a steel mill. And they have all been industrially oriented until just recently. In part we have been industrially oriented in our own AID program until just recently. This has now changed with a vengeance and there is a clear understanding at least in the top levels in our Government, and it is high enough and firm enough and clear enough now that I think it is going to reach the operating levels out in the field.

DR. BRADY: Mr. Secretary, we were talking this morning about some of the limitations in the research and education area that we have had in the past, and perhaps limitations that have been set by the Congress or for some other reason. But most of agriculture's input either through the land-grant colleges or through the Department of Agriculture have been through some agency other than the Department of Agriculture--AID--that is overseas. And it has also been on relatively short-term projects, perhaps a 3-year contract with a university, or in the case of PL-480 or the AID programs in the Department of Agriculture--also on a short-term basis, which isn't conducive to the long-term plans and approaches that you have just mentioned to us. Are there any plans to move on a more permanent basis and away from this short term contract method of handling the research and education input overseas?

SECRETARY FREEMAN: First the fact that both the AID program and now PL-480 run for five years is enough to get long-term consistency in connection with this.

In the administrative family there is knowledge of the importance of the lead time to do a more effective job. And I think there is a broader support, at least so far. I am encouraged by the support for the Food For Freedom program. I testified all day yesterday. As I said, I had some exposure this morning. So far, this looks pretty good.

In the last analysis, the Congress is going to reflect what the American people are going to support. I think the American people are prepared to support the use of our agricultural productivity to keep people from starving around the world. It doesn't have to be much more sophisticated than that. I think there is solid support, and it will reflect inself in the Congress.

I think that same kind of support and understanding, and the shocking realization that in the absence of real progress by these countries themselves there is going to be mass starvation, and that there will never be a peaceful world under those circumstances, is beginning to write in big bold letters for Mr. Average American to understand. That realization is going to have a positive influence in building greater support and understanding for the general technical assistance, including research programs, which as you know have just about run out of support with the American people on Capitol Hill.

But food is another thing. Food is something that every American, regardless of his degree of political sophistication, can understand. And to the extent we can translate some of these programs in terms of food and the need to keep people from starving to death, to this extent I think food is going to help to send this message and to build the awareness of the public so that we can do a better job of long-term planning.

We have some problems on that before the Congress, too, because there are some people who feel--and they are not as numerous as they are strong by virtue of their position--that anything that we do to encourage agriculture, or anything in countries around the world, per se builds an export for ourselves.

This is not an easy one to meet and can be used very effectively with a little demagogery. Here, too, I think the message is beginning to get out. It is quite clear and we can demonstrate it quite effectively, that increased agricultural progress means economic development and per capita increase of income reflects itself almost immediately in increased importation by that country of American agricultural commodities themselves. This story is getting through. Fundamentally the American people have to get behind this and I feel they are behind this food problem now. I think with the leadership of men like you here speaking effectively on it, as many of you have, the prospects are much brighter than they have been.

DR. SEITZ: Thank you very much, Mr. Secretary.

Our next speaker is no stranger to you, since he was chairman of this morning's session. He is Assistant Secretary George Mehren. He has been Assistant Secretary of Agriculture since 1963, with a very varied and rich background in the field of agriculture with a great deal of experience on the international as well as the domestic side.

I understand that he doesn't particularly like to have it generally known, but he is a native of one of the more populous western States, and he was a professor of agricultural economics at one of the universities there.

RESEARCH AND OUR MISSIONS

By George L. Mehren, Assistant Secretary of Agriculture

Let me add my thanks to those of Mr. Freeman. We are here for a good purpose. We are seeking consideration by scientists and public officials from many fields of the proper role, and of the capacity and need for agricultural research. We seek appraisal of our research in terms of our missions. We want to consider whether we have effectively coordinated our own work with other elements of the research community.

Accordingly, our program includes a general analysis of the role of the scientist and of research in general and in the field of agriculture by men outside the Department. We who work in the Department will outline our program and our plans for the future.

The Secretary of Agriculture has outlined the broad and varied and always-changing missions with which we are charged. Our programs touch the life of every American many times on every day. We are a service agency; a police agency; an educational agency; a conservation agency; a welfare agency; a domestic development agency; a foreign aid and development agency; a resource development agency; and a science and research agency. In large measure, from the beginning a century ago, we have been a Department of Agriculture in the broadest sense of the word. We have always had the entire population of our country as clientele, and in recent years our missions have broadened into the world at large as the policies of the Nation have broadened.

A quarter of a century ago we were the largest of the federally-supported research agencies. We are larger today than then, but we are a minute part of the Federal science establishment now. Thus, it is in a context of sharp change in all dimensions of our programs that we seek this colloquy with people in other fields.

The Relationship of Research to Missions

In agencies like ours, there seems to be a sequence of policy and program formulation that runs from broadly specified values; to goals in more precise terms; to targets in quantitative terms; to analysis of target variables; to formulation of consistent administrative mechanisms; to program operations; and then by feedback from program results, back through all or part of the same sequence. Research in mission agencies quite directly services moral values -- but research itself must, of course, be totally free of value content.

So, in agencies such as ours, we are required first to try to express goals as a complex of quantitative targets, and to identify the systems of variation in the targets. If we can do this, all the alternative ways for achievement of targets can be specified, and perhaps even the optimal among the alternatives. We can exclude proposed programs not demonstrably related to targets. If temporal relationships among the targets and their determinants are measurable, we may be able to lay out strategies. If we can do all of this reasonably well, there is rational basis to build administrative structure and initiate program activities.

One quite amoral phase of this complex and ultimately normative process is research -- the asking and answering of a narrowly specified type of question through a narrowly specified methodology. No answerable research question can encompass any normative content whatever. No research methodology can test any issue other than related patterns of variation. Values and goals are served by research in mission agencies, but the research process itself is untouched by value considerations. Once our goals are expressed by carrier variables, there follows the standard methodology of research inquiry -- the formulation of an answerable question and a testable hypothesis, its test, and a decision to reject or not reject. Thus, through the research process there are identified all of the variables, relationships or systems through which the targets conceivably may be manipulated. As the Secretary has indicated, without some respectable approximation of research, targets could be achieved and administrative structure and program activities could be optimal only by accident. In all likelihood, we will never achieve a fully identified mission system, but this really is what we are trying to approximate.

These are the purposes of our applied research. And so, the scope and nature of our missions, the state of the research arts, the resources available to us, and our allocations thereof largely determine the scope and nature of our applied research programs.

Yet, about one-third of our research is not pragmatically oriented. We defend our basic research work mainly as a foundation for our applied inquiry, although there are other good reasons for it. These two types of research really need not, often do not, and perhaps cannot differ structurally. Where possible, the findings from any of our research workers are finally translated by a mission-oriented agency into terms suited for development and technological application.

Thus to build a coherent program of research tied directly to operating goals always engages hard questions of research methodology and organization. The research questions that are derived from program goals are no less elegant or complex than those not so tied. Perhaps the most difficult operation is to structure an applied research administration through which the necessary questions may

be asked and answered efficiently and then be fed into operating programs.

This is the logic of the role of research in mission-oriented agencies. Setting forth the logic, however, does not mean that in fact all applied research is so designed, that all missions are so serviced by research, or that administrative structure or program dimensions are so specified.

Development of USDA Research

President Lincoln, in 1862, charged us with "...acquiring and diffusing scientific and technical information relating to the problems of agriculture in its broadest aspects..." So, as mission-oriented research agencies go, we are among the oldest, with broad, varied and changing missions. And not so long ago, we were the largest. In many ways, the research history of the Department may be a century-old model for other agencies of purposes, problems, methods, achievements and frustrations that they are facing now or will face in the future.

Our research and education mechanisms have been described on occasion as "confused" and "obsolete" and unduly affected with what is called the "agrarian tradition." Yet, a quite different set of hypotheses is fully tenable. Much of the power and productivity of this Nation are measurably attributable to agricultural science. Other characteristics of our society -- open, pluralistic, ambitious, inquisitive, mobile, agnostic and positivist -- are in part the mark of agricultural research and education. The emerging characteristics of the system in other fields seem often faithfully to replicate those in agriculture of decades ago.

The nature of education of people for any kind of science may well render some of its practitioners a little parochial. This apparent tendency may have been heightened by the rising academic and political prestige of scientists in recent years. Yet scientists in agriculture do not in fact seem to be unusually afflicted with professional provincialism. People in agricultural sciences seem to know as much about other fields as is known by others about their own. The field is such that we must draw upon many disciplines in research. The program operations are such that we deal daily with almost every major phase of domestic and international activity.

Agricultural science is largely an applied field -- but there is ample and widely realized latitude for elegance of thought and action. Teaching and research have been tied together operationally in agriculture for more than a century. The extension component was built into the system 50 years ago. For some eight decades, there has been a formal mechanism for coordination of Federal programs with those of the States and the universities. Missions have changed. Some phases of research have become obsolete and have been replaced. But the system itself is hardy. It is lively. It is not a perfect piece of machinery but its performance is still immensely useful and its future is bright.

It may not be too much to hold that life in this Nation -- including its general science component -- could not have become what it is today had not this mechanism for agricultural science been developed so early.

On the other hand, agricultural science curricula in some of the colleges are parochial, insular, narrow and too specialized. Some of them are perhaps intellectually inferior and perhaps some are declining in relative quality of people. Some parts of agricultural science may indeed have been bypassed since 1940 and left behind and alone. If this be true, then remedy is needed. The agricultural sector of America is an important sector and must not ever fall behind. No science and no education and no industries or people can live sequestered and alone.

The fact seems to be that all of our mission agencies draw for research upon the same intellectual resources, ultimately in much the same ways, to the same ends and under the same constraints of budget and political processes.

To hold that agricultural science is a fruitful field is not a counter-exercise in polemics or in invidious comparison. Nor is it an apology.

There are two immediate purposes here. The greater is for us in agriculture to learn from men in other fields. The other is to tell men in other fields who we are, what we do, how we do it, and where we are going. We know that agricultural research must not be or remain apart from other fields. And there is much in agricultural research that can be of help in newer applied fields.

Again with no defensive or offensive intent the translation of agricultural science into industrial application has served us well. As example, in the farming sector alone, the use of 1920 technology would have required 27 million workers -- instead of the actual 6 1/2 million -- to turn out the production of 1963. There are farming, processing and distribution industries in which research seems to be translated into technology almost over night. The measured yields of investment in applied agricultural science have been high.

People in agriculture seem generally to believe that the performance of agricultural science is still good; still pre-eminent in world science; still vitally necessary to future productivity; still abreast of advances in the basic sciences; still important in developing new plants, animals and techniques; and still an important element in education. Yet many of us know that full verification of all of these beliefs might not be easy, and probably not very useful. The compelling fact is that future adjustment most surely will be required.

What is Agricultural Science?

Agricultural science can be defined in several ways. In one sense, it is the application

of scientific methodology to questions of pragmatic significance in agricultural operations. It could also be precisely defined somewhat less effectively as the activities of those who are called agricultural scientists. Yet, again, agricultural research draws on virtually every discipline of science which is unmarked by resource or functional adjectives. Its differentiation from other applied fields therefore must depend largely on differences in operating missions. In large but by no means full measure, our research program is what our missions and those who set them cause it to be. The missions require particular complexes or combinations of general sciences. Those combinations therefore could also be called agricultural science.

Not all our research is designed ex ante or in systems, but much of our mission research should be and increasingly is so constructed. Most of it has more systems design and more coordination with other fields than may appear on the surface. We in the Department are a long distance from precise identification of missions and classification of our activities in mission categories. We are a longer distance from relating all of our applied research activities to our missions. It is very doubtful indeed that all of the research of a mission-oriented agency could or should be mission oriented.

Among other factors, there is, and perhaps must and should be, some control over programs and research by political processes at several different levels. Other agencies experience these same constraints. There are other compelling reasons precluding design for all research activities.

The dollars of budget generated for support of a mission probably affect the dollars allocated for supporting research. But in agriculture there is no apparent correlation of all of our mission and research allocations, and probably should not be for every mission. Some of our major missions have relatively little research back-up. Not every one of our missions requires the same kind of research. There is no necessity that program outlays and research outlays always be proportional for all operating goals.

Scope and Nature of Agricultural Research

As one phase of the long-range research plan now being formulated by the Department and the States, the first Federal-State research inventory is completed. We can retrieve some 800 combinations of activity, commodity or resource, and field of science for the approximate 16,000 Federal and State projects involved. We can print out substantial information on non-land-grant academic and industrial research as well as our own.

Already we can identify some complementarities among these various activities; some duplications; and, in some cases, gaps in systematic specification of questions necessary to achievement of mission. Already, our design of specific packages for specific goals has been greatly facilitated. Now we are appraising our present allocations and trying to formulate reasonably effective criteria for reallocations.

Net derivatives of research investment cannot really be neatly equilibrated in all directions -- but in effect this is what we are trying to approximate. Such equilibration requires multi-target, multi-discipline and multi-agency references -- and this is not easy. In trying to optimize our research, there will have to be feedback from operating programs. There will have to be identity or at least workable compatibility of research inventories with the storage and retrieval systems we are developing for our library and for our current research appraisal system.

Despite these limitations, we do intend soon to submit five-year projections of research activities and required support for them. We regard these projections as strategic tracks, and we are providing latitude for short-run tactical shifts.

I think, therefore, that we can say with substantial accuracy that we and the States now know far better than before what we are doing. We shall very soon be able to say with some degree of precision where we want to go and the paths we want to take in getting there. And we can see far more clearly than before that in getting there, or anywhere, we must find a far higher measure of coordination of all of the phases of our work with that of many other agencies.

Essentially, we are some seven department research agencies tied to State universities and a few others through joint planning and cost sharing. About 20 percent of our people are in university facilities and 30 percent are in university communities. In 1965, we spent inhouse about $183 million in research and allocated about $14 million on contracts and some $50 million to the States. The States in general contributed in the ratio of about 3 1/2 to 1.

We employ about 5,000 and the States employ about 10,000 professional people. They are recruited, thus far without major difficulty, with no apparent concentrations in areas or institutions. We contribute to the support of about 2,000 graduate students.

Virtually every basic discipline is represented among our people. Chemists, social scientists and engineers account for three-eighths; geneticists, structural biologists and entomologists together about one-fourth; other biologists, pathologists and pharmacologists, about one-sixth; and the remaining approximate 20 percent are distributed among 17 other fields of science.

In subject-matter terms, we had in 1965 some 2,079 people in farm research; 946 in utilization; 141 in consumer and nutrition research; 235 in marketing; 1,177 in forestry and 575 in economic analysis.

Geographically, our personnel are widely distributed with some concentration in areas

of high-level farming activity. There are about 780 field stations -- almost surely too many and a few are unduly small and isolated. Yet, considering the constraints impinging on us, there is no alarming dispersion or concentration of people or facilities.

Roughly one-third of our own work is basic, without immediate orientation to pragmatic application by us or others. The exact proportion of our work done by design or systems is not yet precisely known but soon will be.

The diversity of research operations and kinds of research people reflects the immense diversity of our operating missions. No one, at this stage, could really appraise precisely the degree to which we have -- or have not -- optimized our research allocations among disciplines, concentrations of work, places or institutions. Yet, at the working level at any rate, there seems to be no glaring deviation from what might be considered optimal or nearly so, if constraints are considered, in conjunction with missions.

Allocation or Balance Criteria

Ours is a fairly large-scale operation, with command lines diffused, and with a scope of research questions far broader in fact than the usual specification of our missions would indicate. The major difficulty in allocation for us as for others, is the absence of quantitative specification of target variables and estimation of productivity and costs of research inputs. This lack clearly impedes achievement of optimal research balance. We do not, in honesty, yet know how to achieve such balance, or even whether it can be achieved other than by the judgment bases now used in research agencies generally. But we do know the questions for which we must seek solution.

Specification and weighting of norms are not thus far susceptible of quantitative specification. Equilibration of inputs might be so susceptible for given norms and weights, if input-output relationships and costs were known -- but these of course are unknown. So, apparently, allocation decisions are and must be made on what is called judgment -- and usually is not specified meaningfully. There seem to be no operational definitions of what is called "balance."

Even so, canons of quality are suggested: novelty; widened command over nature at a low cost; generality of findings; possible complementarities of method; expectation of contributions to national goals; easy translation into enhancement of productivity; cultural impact; preservation or enhancement of future productivity. Ultimately, all of these general criteria seem to be subjective, arbitrary and non-operational. They can only serve as rough guides in deciding how to frame a research program in an agency like ours.

Yet research and research people are judged by us and by others. The very good and the very bad can be identified easily. Not so the large middle. I think that we really do not make our choices so much between broad areas of research as we do among individual proposals. We can, I think, make reasoned judgments of the consistency and complementarity of such projects, and we can in fact judge the competence of those who propose them.

Whether, and if so, how much, any government agency should invest in research are also quantitatively unresolved issues. Identification of net contribution to public goals does not seem possible even for such limited and generally-supported areas as desalination or conservation. It is doubtful that broad areas or individual projects can be supported solely because of the assumed capacity of a rich economy -- which is not rich uniquely because of science -- to support research as a sort of a general obligation.

The appropriate investment -- if any -- in total or in specific projects that is necessary or desirable to maintain American science or program "leadership" cannot in practice be specified.

In fact, in a project or in any aggregate of projects or systems, there seems to be a multiplicity of targets, and the equilibration of inputs is vastly complicated in consequence.

Relative weights of missions change over time, and costs and yields of research inputs are also temporarily interrelated. I doubt that there should always be a static or declining research budget for agencies with declining relative importance of mission -- and I do not have the Department of Agriculture in mind as the only example.

I am uncertain of the competitive nature or efficiency of the "free intellectual and commercial market" as an allocating mechanism. It is widely believed, even if undemonstrated, that such a market, even if it were competitive, would result in underinvestment in questions of social rather than individual significance.

We do not really know the degree to which the economy can afford so-called "open-end" science solely because such budgets absorb a small part of the national product.

Whether research itself -- either basic or applied -- may properly be considered as a sort of long-run social overhead investment is thus far a matter of individual preconception. The meaning of "intrinsic research" is not clear. It appears desirable to heighten the state of the art, but this is no compelling basis for allocation against competing claims of many kinds. Rightly or not, in our present program planning for the Department as a whole, we do not classify science or education as goals.

The causal sequence, if any, from basic research to applied research and then to enhanced industrial productivity is not yet exactly established. Even so, the apparent promise of quick transition to technology seems to be a major criterion for allocation in some instances.

We in the Department have been criticized both for inadequate relative emphasis on basic research -- and despite a remarkable record -- for unduly light relative emphasis on development.

All of us must make allocation decisions all of the time. Research competes against operating programs, including those it serves directly. Even within an already-budgeted research activity of fairly narrow scope, there are balance issues among alternative disciplines, methodologies, people and places. We try, for example, simultaneously to upgrade all State Experiment Stations through formula grants, while trying to solve systems questions and to build excellence through individual contracts or grants. In doing so, we resolve, rationally or not, an immense battery of competitive claims among missions, research questions, places, types of agencies, disciplines, methods and people. Implicitly, we are judging the relative productivity of all these alternatives. Usually we do it on the basis of preconceptions of men who we think are creative and technically competent. At the moment, there may be no better way.

We have machinery through which these allocations are made. We have a comprehensive mechanism to link the States in generating and appraising the work of their people and in trying to coordinate it among themselves and with us. We have many research advisory committees. We now have a research program development and evaluation mechanism. We have a Department-wide programming system for all of our missions and activities. We are subject to Budget Bureau and Congressional review. We work with many private research agencies and with science coordinating units of the government.

Even so, I suspect that we leave inadequate tracks of that which almost miraculously turns out to be a reasonable and fruitful pattern of activity. It is not optimal perhaps. It is generally impressive intellectually. It is not arrantly foolish or inefficient. Personally, I am puzzled that performance looks so much better than the administrative machinery through which the performance is apparently achieved.

Some research is funded because we know the individual to be creative and competent. He will ask good questions and answer them well. Other research is supported because we are enjoined systematically to enhance the research capacity of the institutions -- and of this we approve. In other cases we look for competence in answering questions within systems or in resolving program problems of immediate moment. Finally, we make some allocations to maintain what now are called centers of excellence -- and of this we also approve.

But we have no optimization variables to represent missions; we do not know input-output relations of research resources; and we apply no formal equilibration analysis. Nor does anyone else.

Despite this, I want -- and so do my colleagues -- to know more precisely what we do; to explore without surcease the possibilities of a real allocation calculus; and perhaps in the process to defend against efforts to organize research exactly as some operating units are set up. Our research has been worth doing -- and it is now.

Administrative Structure and Mission-Oriented Research

Administration generally is defined in terms of lines of command, reward, budget, accountability, appraisal and adjustment. The operating facts of these administrative lines among the immense number of interrelated activities in our Department are far too complex for easy description. Neither we nor any other public research agency has full latitude in these administrative decisions.

There are complementarities, overheads, scale economies and diseconomies and indivisibilities in research, and they must somehow be managed. There are difficult allocation issues even within a single project. So, costs and efficiency implications of alternatives usually must be guessed.

The climate of work is vital to a creative man. At some level, some decisions must be his.

Mine is a modest goal, just now. I want to see if we can find administrative structure by which we can reasonably manage some reasonable combination of basic and systems research, some institutional, some individual, some designed and some aimed at excellence. I know that we look diffused, fragmented and uncoordinated. This is undesirable, and not necessarily because quality of output is adversely affected. I oppose a monolithic administrative line, for reasons good research men will approve.

As things go now, we seem to achieve at least a workable balance of individual initiative and internal and external coordination. But the perfection of research administration is a major area of inquiry for us. Our programming and our information activities should help us substantially.

Yet, ultimately we will be required to match our administrative structure to our research program -- and we have begun to try.

Scientific Personnel Policies

We are fully equipped with the standard personnel machinery and I think ours is well intentioned and efficient. But there are difficult questions in this primary phase of our work that are yet unanswered, and there are policies and procedures used elsewhere that we should consider for ourselves.

We need first to consider how we can shape our own research program to guide desirable outturn of scientists and teachers. We need

to know whether people trained in basic sciences can later function both as basic or applied scientists. We need appraisal of the places in which they are trained.

There are institutions which recruit against the world. I want to know whether we can do so.

There are procedures for appraisal of performance and advancement to tenure status or beyond not used by us. I want to know if we can adopt them.

Other institutions have different post-doctoral or other in-career training procedures. We have large-scale programs, but alternatives must be weighed.

We need to find acceptable scientific environments in the face of a dispersed operation. The status of a government scientist must not be denigrated.

We need an estimate of the populations of different kinds and qualities of agricultural scientists.

These are not major deficiencies, but there are possibilities to heighten the productivity of this major research resource.

Conclusions

Agricultural research has helped to free many men from the struggle to feed themselves. In the past, it has contributed much to the character of life in this country. I think it is still a vital element of our society. We clearly must do now what others also must do -- define our values; translate them to missions; turn our missions into targets; analyze our targets; and then tailor program; we must find criteria and measures adequately to allocate our work. We must build administrative organization that will contribute affirmatively to our goals. We must find and train scientists, and give them adequate working environment.

But most important, we cannot operate in detachment from other research. We cannot incept in the research process -- detach ourselves from the moral values that finally give some guidance to our applied science. Some people say that science and morality are hard to separate now. Science by definition is bereft of value. If it is to play its applied part in achieving goals, it must of course remain so. In the context of applied research, there seems clear compulsion for close coordination of work by many agencies. Surely there is really no separate agricultural science. Glenn Seaborg has written that "We are headed for some new and undiscovered shores ... long separately, now together ... I think it is science which has made this so."

DR. SEITZ: We are open for questions or comments.

DR. HANDLER: You confined your discussion very largely to the in-house programs of the Department, in-house being Department of Agriculture or in-house being State stations that receive Department aid. You did not address yourself to the obligation that the Department may owe to the wellsprings of science outside. Other agencies of the Government have found this almost essential. What do you think about this for Agriculture?

DR. MEHREN: I don't disagree with you in any measure whatsoever. I think we have rather more internal support of sciences unblessed with any disciplinary adjective in front of them, or any applied term in front of them, as most people think. I know this to be true in many but not all of the States with which we collaborate. But I think it would be wise for us, unequivocally, to say to ourselves that this is an obligation in our own interest as well as others, and not to fail to say it before people like you, and I will not again fail to say so before people like you.

DR. MC ELROY: Do you have a rough idea of what your total R&D is in this direction?

DR. MEHREN: I don't know. Mac, do you have that?

DR. MACLAY: Our contract grant work now? Outside, something like $14 or $15 million. Maybe George Irving knows it.

DR. MEHREN: The contract work is $14 million. It is not all R&D. The question is: how much really deals with general sciences and not scientific combinations directly oriented toward specific agricultural goals. That was your question. I don't know that answer yet.

DR. HANDLER: What about general science done outside the framework of the Department of Agriculture laboratory or State station?

DR. MEHREN: We have a large number of contracts. George Irving has non-land grant universities.

DR. IRVING: That is correct. I don't have the estimate at my fingertips, but there is considerably more than appears on the surface. Most of our work in chemistry is not with the chemistry departments. You might count our pioneering laboratories which amount to between two and two and a half percent of our total research and programming funds. They are as near the academic atmosphere as you can get. In many of these cases we are planted in the academic atmosphere deliberately.

DR. MC ELROY: I don't know whether the figures are meaningful, but it is interesting

to look at other mission-oriented agencies. Roughly 10 percent of the total R&D budget goes to research. I don't know whether that is good or bad.

DR. MEHREN: I would say we go much more than 10 percent to research. Unless you call utilization development.

DR. EMERSON (Dept. of Defense): I would like to comment on some of the questions you raised. Being probably the biggest spender in R&D, Defense has been under closer scrutiny by all levels of Government and many other activities such as some of the non-Government agencies. I think you could profit a great deal by looking at the studies which have been conducted on our research programs and the findings of those which have been in progress about three years. We have a couple still going. Just to save yourself some trouble and help guide you in examining your own problem, I think it would be very worthwhile to see the methods that were used in analyzing our program.

DR. MEHREN: I did say that the one real criticism of my friends and colleagues is that they do not leave tracks of the very essential things that they actually do. I have every last piece of paper on your system of research inventories, your storage and information procedures. Our library people, our research people, have been working day after day with your people. We have molded it together. We are in the process of considering a summary feedback for computer processes identical and compatible with that which you and NASA have. But they don't leave records of it. They are doing this all the time and there is a high and most gratifying measure of compatibility between your research inventory, your research allocations, your storage and information activities and ours. But our people don't have it out where some outsider can see it, and consequently they say it is confused and fragmented; but the results are good. Collaboration is as close as you can get it.

DR. EMERSON: That aspect isn't what I had reference to. I was referring to the examination of a mission-oriented organization by outsiders, their evaluation of whether we were meeting our mission, whether we had a proper structured program, in-house versus contract, and applied very basic research, and their attitudes and types of questions. This is what I was referring to.

DR. MEHREN: We have also done some of this. I don't think we had the right agencies do it, myself, with no offense to GAO. I don't think its appraisal of our research activities was the kind of an appraisal that is particularly useful to us who are in administrative positions. That is the next step coming up.

DR. ALDRICH: Thinking of this question directed to George Irving a few minutes ago -- as to the amount of non-agricultural involvement of agencies on a campus in research pertaining to agriculture as being somewhat meritorious and evidence of it being thought as having merit to those who are examining the program from the outside -- we in agriculture have created somewhat of a Frankenstein for ourselves, George, along the way, because it occurs to me that there are many men in departments of chemistry, of physics, of mathematics, in social sciences, on campuses across the Nation that are involved in research, very basic research that applies to agriculture. But what we have done is given them joint appointments, and their work is identified as an activity of the agricultural experiment station when, pure and simple, they have been professors of chemistry, sociology or botany. And therefore as you scan the programs of a campus it always seems as though it has been an activity of agriculture and not involvement of the non-agricultural dimensions of a campus, and this is wrong. This leads to the notion that we don't spend money supporting researches in other agencies when we actually have done so, but we have identified it as agricultural experiment station work.

DR. MEHREN: This is true.

SECRETARY FREEMAN: May I ask what is the number generally? Did I understand you to say it was ten percent of research going to basic as distinguished from applied? Is that the working number that has surfaced here?

DR. MEHREN: No. The tentative conclusion would be about one-third of our research expenditures is on work that could properly be classified as basic. That is correct, is it not?

What I can't say yet, Mr. Secretary, is that out of the two-thirds that falls into the applied area, how much of it is really spent for development. I know my first candidate to put through the mill to find out, and that is our utilization research. I frankly don't know how much of that activity is research and how much is development. That would be the place where development expenditure would be expected to be highest.

VOICE: That is correct.

SECRETARY FREEMAN: There is a lot of basic research in that. I just observed that as a complete layman looking at the laboratories.

DR. SEITZ: Ten percent is an across the board figure nationwide. Also in the Government.

DR. RUTTAN: A couple of years ago when we were working on the review of research in the national resources area, a great deal of what was reported as research throughout the Federal Government was essentially data production. I am wondering to what extent that is simply measurement of data that emerges from the process of the economy. I wonder how your review within agriculture is coming out with respect to this particular activity. The effect was to greatly magnify the amount of funds that appeared to be spent on research.

DR. MEHREN: Our Statistical Reporting Service is a data-generating mechanism and data-recording and disseminating mechanism. I have some preconceptions with regard to certain components of our research work as

being a little bit descriptive and perhaps primarily generative of descriptive data, good or bad. I can't say with any precision how much it is, but it does not look to be a serious distortion, Vern, so far as I can see.

DR. RUTTAN: I didn't say it is important. I say it is not research.

DR. MEHREN: By the same line, our operating agencies, market news, grading and statistical reporting, cropping projections, forecasting, might be woven a little bit more closely into some of our research activities as sources of data, which is a rather different slant from what you have.

I can't answer your question other than to say that it does not look to be a distressing situation.

VOICE (Interior): What proportion of your research is to the non-land grant universities, and are you trying to expand it?

DR. MEHREN: George, how much do you put into non-land-grant universities? You have $14 million worth of contracts. You have some sort of basic research grants which you have localized in what? Three universities? One of which is a land-grant of a sort. And it is a center of excellence, if you will forgive me. You answer the question.

DR. IRVING: It doesn't exceed 40 percent in the non-land-grant. It is probably a little less or a little more. It is of that order.

DR. MEHREN: Forty percent. So it isn't very much. Three or four million dollars at the moment.

VOICE: Are you trying to expand this?

DR. MEHREN: I have no such feelings personally. As I say, we do operate under certain Congressional enjoinments, mandates, constraints. We don't make these decisions with full latitude.

VOICE: Don't misunderstand me. I am from a land-grant university and I am all for a good thing. I am curious about --

DR. MEHREN: On some types of systems work, some types of problem solving work, we should go to the place that can give us our answer most effectively and the cheapest. That may not always be a land-grant university.

DR. UPCHURCH: This goes by the type of research that is involved. As Irving said, you go to whereever you can get the job done best, quickest, and with greatest confidence.

DR. SEITZ: I suggest we break for 15 minutes and then return.

(Recess)

DR. SEITZ: Our next speaker is president Elmer Ellis, of the University of Missouri. He has been president of that institution since 1954. He is a North Dakotan by origin. Interestingly enough he started as a professor of history, and his interests have been in the history related to political, economic, and cultural history of the United States. He has been recently, I beleive 1964-65, president of the National Association of State Universities and Land Grant Colleges. He is going to speak about the land-grant university's role in research and agriculture.

THE ROLE OF LAND-GRANT UNIVERSITIES IN AGRICULTURAL RESEARCH

By Elmer Ellis, President, University of Missouri

I am proud to represent the National Association of State Universities and Land-Grant Colleges in this session. I recall a somewhat similar occasion when I had the honor of sharing a program with Secretary Freeman and David Bell of AID during the International Rural Development Conference of July 1964. One very significant byproduct of our concern in recent years with economic and rural development abroad, and of our part in it, is a better appreciation of our own research institutions and their contributions to our economic development. For example, it is now apparent to many of us that our agricultural research has made a tremendous contribution to our industrial development by helping to improve the availability of the necessary labor, capital, management, and energy.

Recently Russell Thackrey stated: "Seriously, it is no exaggeration to say that in all those countries of the free world which are striving toward a better life for their people -- the idea of the Land-Grant University is America's most popular export."

Land-grant universities are peculiarly American institutions. Initially, they were a hybrid combination of the English colleges for undergraduate teaching and the German universities for the cultivation of scientific research. Over the years the recognized needs of our citizens have greatly broadened and so have our universities. Still fundamental, however, is a commitment to the democratic proposition that "there are extraordinary possibilities in ordinary people."

It would not be contradicted in this group that education and the universities are the answer to many of our pressing problems. But to what specific problems? In earlier times, a university was a conservator of knowledge. Someone has noted that university libraries, for example, were usually designed like bank vaults.

The classical library story of that period was about the president of Harvard in the 1850's strolling across the campus and meeting the superannuated professor who acted as librarian. The President stopped to chat with him and asked him how things were in the library. He said, "Pretty well. Every book but one is in its place on the shelf. Agassiz has that. I am after it now."

Today we expect the university to be not only a preserver but a developer of knowledge. In fact, we are caught up in a 20th century revolution in which it seems certain that more scientific knowledge is being discovered and applied per year than occurred in the whole of the 16th century. As a society, we are engaging in an unprecedented and tremendous undertaking to transform our society. In short, we are engaged in that socially essential task that Schumpeter called, "creative destruction."

The consequences of this scientific revolution are gradually being perceived. It is fairly clear that we have been left behind philosophically. Some of our political institutions must try to catch up. On the individual level, the "life of an education" is so short that continuing education is absolutely essential--especially for college graduates. Citizens can expect little better results from practicing 1930 economics than physicians can if they practice the medicine they learned in medical school a few years ago.

All of this is to say that the universities are revolutionaries which are allied with other elements of society in transforming our world. As Oliver Carmichael put it ("Universities: Commonwealth and American." Harper. 1959, p. 53):

> The scholar in the modern university has come down from his ivory tower into the market place, and is thereby making spectacular contributions to the economic and social progress of his community, state, and nation.

My point about the revolutionary age in which we live is not new, but it is central and we must focus on it to perceive the role of land-grant universities in agricultural research or medical research or engineering research or even undergraduate teaching. The colleges of agriculture, including the experiment stations, are part and parcel of these university developments. In fact, colleges of agriculture have been among the most influential divisions of our universities in changing the university's environment and man's way of life. By their successes they create the necessity of further change in college curricula and research programs.

Our colleges of agriculture are no longer separate and distinctive parts of the university. I will cite only a few of the several measures of their growing integration. Other divisions of the university are rapidly developing general extension education in conjunction with and in emulation of agricultural extension. All college undergraduates now take a large core of Arts and Science courses, so that a B. S. in agricultural science or agribusiness indicates an education fully equal to its counterparts across the campus. Contributions to the solution of agricultural problems often have produced implications outside of agriculture. For example, at our Missouri Agricultural Experiment Station we have a herd of hogs with the very unusual and important characteristic called hemophilia. Research with these animals has important implications in the human health field.

It is becoming increasingly apparent that farm people have many of the same interests and educational needs as other citizens. The rural-urban dichotomy in our thinking and in

our programs is too often a hangover from a departed past.

My next point concerns the awesome demands which we as a society make upon ourselves. As we develop our capabilities, we extend even further our expectations. To reach the moon, to eliminate cancer, to find ways for our world to feed our children, and to make economic opportunities for all our citizens, are but a few of the staggering tasks we have accepted for ourselves. Such awesome expectations are based upon a consuming faith in the capabilities of scientific research. We translate these expectations into tremendous Federal research budgets and into a flood of crash programs of research.

The marshaling of research and researchers on a mass scale is a relatively new development in the history of mankind. Less than a century ago we would have solemnly agreed on its impossibility. Certainly we cannot mass-produce Einsteins nor spectacular breakthroughs, but we can mount a Manhattan project with far-reaching cumulative results. Our whole fantastic Federal research program is based on such a premise.

Research is power, and national research is equated with national power. We have much to learn about organizing and mastering this new national power. Our experience is limited and our institutional arrangements for handling these skyrocketing programs are still in a state of flux.

It is obvious that the Federal Government must be deeply involved in research. It is equally obvious that the universities must educate the scientists who do the research. It is also certain that the universities will accept responsibility for parts of the national research program. Questions arise as to how the universities can participate in a manner that strengthens their capacity to train scientists and that strengthens their capacity to perform their other functions in our society. In the process of accommodation there are bound to be changes in the universities, but we must avoid any distortion of the fundamental pruposes of universities in a free society.

The Federal research programs have generally respected carefully the objectivity and academic freedom of the university researcher. Unfortunately, we cannot say as much about their dealings with universities. One shortcoming -- that of pyramiding funds at a few prestige institutions -- will hopefully be abated by new policies including President Johnson's memorandum of last September 14. The significance of that memorandum is in recognizing the institutional impact of these research monies and in directing that they be spent to maximize long-run returns to society.

Another shortcoming relates to the preponderance of project funding over institutional funding. I admit immediately that project grants and contracts directed from Washington have many merits and often are an essential part of the Federal program. All universities attempt to participate -- often unwillingly. Like medicine, some project grants are good, but too many can be detrimental. At its worst, the financing of a university research program by grants and contracts creates an "association of independent contractors" within a university. In this extreme the university administration's position is relegated to that of a landlord who provides space and utilities to those who choose to reside there with their Federal grants. Playing the grant game can produce the kind of gulf between absentee professors and students caricatured recently by Art Buchwald and others. Excessive dependence on grants produces a research system which prevents the close coordination of scientific investigation with graduate education and with the needs of users in each State. It thus works against the system which has been highly successful in the field of agriculture.

We need to find a more proper mix of grants and institutional support for research. It was natural for the Federal Government, especially in national emergencies, to depend heavily upon very specific control of its research funds. Gradually it has shifted as it recognized the greater social costs of the grant system and as it became aware of the strengths of institutional fundings.

The project grant system has been discussed many times before. It is now obvious that it is not as socially efficient as it first appeared -- that the excessive pursuit of grants becomes a costly and time-consuming preoccupation of scientists who ought to be in their laboratories. The land-grant triad of research, teaching, and extension is torn apart at the seams when there is too much dependence upon grants. It is a bitter indictment that in some situations the biggest reward a professor can receive is to be told that he does not have to teach, or even that he must not teach. And the "good news" comes from a Washington granting agency, not from his dean.

A justification often given for project grants is the ability to obtain focus upon specific and present problems. This point has been grossly oversold. A considerable amount of focus and coordination can be obtained within the institutional framework, and I concede that more specificity is often obtained by grants. However, I want to raise two questions about this specific focusing of research. It should be clear by now that research results rarely fit into preconceived bounds. The spillover effects of research are so large that it is being cited as a justification for research itself.

A classic case concerns Karl Link of the Wisconsin Agricultural Experiment Station who was approached by a farmer with a dead cow and a pail of blood. Out of Link's research on this specific problem came the development of a potent rat poison and an anticoagulant of great importance in medicine. Recently work at the Missouri station on ways

to increase the number of pigs per litter has led to the discovery of a way of unlocking the DNA in sperm cells, and thus another step has been taken toward fundamental knowledge of the secret of life itself.

We go through numerous research inventories to satisfy the demands of new Federal programs. How much research are we doing which is related to environmental health, or water resources, or economic development, or weed control, or effects of pesticides? Obviously, these research efforts are often so interrelated that the sum of these specific inventories must exceed the sum of our total research. An astute observer made the point furthermore that the coordination of research effort can be obtained best at local institutional levels. The independent project request route, for funding at the national level, makes it extremely difficult to manage research inputs so as to do justice to both long range and immediately urgent research needs of national, state, and local import.

A good hard look ought to be taken at the patterns of our specific research requests since World War II. I am afraid that our foresight is pretty limited and it is often difficult to explain the reasons for what was in vogue yesterday and what is popular today in research granting agencies. Before we reach the moon or learn all the effects of pesticides, other and equally pressing problems will be upon us. Basic sciences of little interest today may be thrust to the forefront tomorrow. Even more likely, many of those scientists engaged in today's problems will drop their unfinished tasks to spring to the new "crises."

Admittedly, if a crisis is very real, this flexibility represents national strength. But the scientist can be pardoned for wondering why he can get no financial support for many years for a problem of obvious importance in his view and then suddenly he and his fellows are besieged with offers of more money than they can efficiently spend on that very same problem. Under these conditions even the most idealistic, ivory-tower scientist becomes a cynic. Would it not be wise to admit that "we see through a glass darkly" -- that our specific problem foresight is so limited that we must increase our strength across the board? Else we will generate tomorrow's crises by the artificial scientific scarcities we create today.

An analogy would be to change our college curricula in response to "national crises" so that all students majored in marketing when it was "the problem," all majored in chemistry or entomology when the pesticide crisis occurred, etc. As Ervin Peterson commented a few years ago while Assistant Secretary of Agriculture: "There seems to be a popular conception that research, and particularly agricultural research, is a sort of magic wand to be waved when the need arises and then to be quiescent until the need arises again." ("1959 Proceedings of Land-Grant Association," p. 132).

I realize the temptation to sell research programs to the Congress in terms of specific problems and the anticipation of immediate results. I think it is becoming clear that the universities are coming out a poor second best to the Federal research agencies and even to the big private consulting companies in this sort of exercise. When the Congress is shown a fire to be fought, it is easy for a Federal agency to suggest that Congress should support its big Federal fire engine rather than spread money among 50 States with, so it is alleged, their individual buckets of sand. Lest I be misunderstood, let me reemphasize that there are some very real fires burning in the world that demand the best efforts of all of us -- Federal and State. That is all the more reason for staying away from the ersatz and the carefully fanned flames-type of little crises.

I have seen the Hatch Act support of the experiment stations referred to as an extramural research program of the USDA. I think that to be an unwise choice of words. Those who passed the Hatch Act did not consider it to be a new way of expanding USDA research. The USDA was connected only for administrative convenience. When Justin Morrill became a Congressman in 1855, he was interested in establishing a national agricultural school somewhat similar to West Point or Annapolis. By the time, 2 years later, of his introduction of the first draft of the land-grant bill, he had shifted to the idea of State colleges -- a position which finally prevailed in the second and successful bill.

Each of the subsequent Acts -- the Second Morrill Act, the Hatch Act establishing the agricultural experiment stations, and the Smith-Lever Act establishing agricultural extension -- developed these basic concepts further. Each of these Acts provided for a partnership between Federal funding and State administration of the colleges. There were many who doubted the wisdom of Federal funds appropriated without detailed Federal controls. They doubted the existence of the necessary maturity and responsibility within the colleges.

Looking back now on a century of the land-grant colleges, three-quarters of a century of the agricultural experiment stations and a half century of the agricultural extension service, it is apparent that the decision to put faith in the maturity and accountability of the State agencies was a wise one. In fact few would argue that the accomplishments in teaching, research, and extension would have been half as great if these colleges and experiment stations had received their funds and performed their duties on the basis of carefully prescribed contracts or project grants from the Treasury Department or even

from the USDA. The very idea of such tight controls is almost unimaginable now, so well established is the land-grant way.

Fortunately, the independence of the experiment stations from the USDA has been generally preserved. I think most of us would regard the Hatch Act as an outstanding example of what President Johnson has called "Creative Federalism"--a partnership between Federal and State for the benefit of the whole society. It is significant that the Hatch Act system was ranked first among alternative grant systems by researchers polled by the House Select Committee on Government Research (reported July 31, 1964).

In view of the tremendous success of the Hatch Act and of its emulation in the Water Resources Act and in some other forms of institutional funding, it is incredible to me to find that Hatch Act funds are cut in the present Federal budget sent to the Congress. I view this cut as extremely short-sighted and that it threatens to erode seriously our already overloaded scientific base.

Equally disturbing is the fact that Public Law 88-74, funded up to now at token levels, has no funds budgeted for the next fiscal year. Surely it is obvious that States cannot schedule or plan for obtaining the State matching funds for these facilities grants. I dare say some States have now been embarrassed or have reduced their efforts for State matching funds, when thus far Federal funding has been so inadequate and erratic.

It would appear to be far more efficient to budget the funds at the sustained level of 12 million annually as recommended by the National Association of State Universities and Land-Grant Colleges. It is extremely difficult to turn "off and on" the whole array of architectural and faculty planning efforts, much less those efforts associated with obtaining the matching funds from the State legislatures. I would suggest that stability in funding at this modest level of 12 million would result in more well-planned facilities, where scheduling of particular efforts would yield predictable and efficient results.

The irony of this lack of support for facilities is further emphasized by the increased USDA contracts and grants and the housing and support for 2,300 USDA scientists now located at State stations. We love them but we serve as unpaid landlords for a substantial USDA research effort.

In a period when concern is being expressed on the impact of Federal research grants on teaching and especially undergraduate programs it is hard to conceive that the Morrill-Nelson Funds should be cut from $15,500,000 to $2,550,000. The report by the Committee on Government Operations, of last October, which recognized the necessity for training researchers for the future, recommended increased attention to the improvement of teaching, to correct imbalances caused by greatly expanded research funding in some areas.[1] The impact of this reduction will not only affect the programs of the colleges of agriculture but will result in the diversion of funds from teaching in other divisions of the university sorely pressed to meet the needs of expanding enrollments.

In considering the role of the land-grant universities in agricultural research, it is necessary that we understand the overall role of the university. This statement by John Gardner, while president of Carnegie, summarizes the point I have been trying to make. "...in its overseas activities as well as at home, the university will function as a university and not merely as a pool of technical talent or an employment broker. It will remember that its unique role is not only to apply present knowledge but to advance the state of knowledge, not only to supply experts today but to train the next generation of experts." (Gardner Report on AID-University Relationships, p. 11, his italics underlined.)

Recently a committee at Iowa State University reviewed the agricultural research program and made the following recommendation: "The College of Agriculture must be dedicated to service and usefulness, the first element of which is scholarship and excellence in research. The second element is to allocate its resources to those kinds of research which are expected to have the most significance over time. A portion of the research work will be of a basic nature and therefore not predictably of use in problem solving. But as a state-supported institution part of our research effort must be local and empirical to lead and guide the state in its development."

West Virginia University President Paul Miller has pointed out that the agricultural college is "...perhaps the most carefully reasoned organization for the production and application of technology that has been perfected in the United States." Certainly this research organization will continue to apply its efforts to increase agricultural output and to reduce food costs. There is fortunately now a somewhat better climate than even a year ago about such production research. In any case it is clear that society cannot let this research lapse even if at times its results, in terms of lowering food prices, are irksome to farmers. This production research has made the rural environment very favorable for corn, hogs, alfalfa, and cows. It is no discredit to this research that it has not done as well by rural people--both farm and nonfarm.

We must now increase the research emphasis upon resource development--human and physical. In one view: "There are only resources. The natural resources and the

[1] Conflicts between the Federal Research Programs and the Nation's Goals for Higher Education, 89th Congress, 1st Session, House Report 1158, dated October 13, 1965.

human resources together are the warp and woof of one fabric--the fabric of human society." This country has always been interested in and involved in developing its resources. What I sense is a new resolve to develop our resources for the economic improvement of all of our people. The closeness of land-grant universities to rural problems and people gives them a big advantage in resource development research and education.

This resource development problem is so comprehensive that it challenges our best efforts as university researchers and administrators. The specific problems range from poverty to water pollution, and from the underemployment of human talents to the overemployment of urban real estate. The Federal agencies charged with specific responsibilities are so numerous we can hardly maintain contact with all of them. Some of the research requires a regional approach and few of the results are bound by State lines.

I foresee more and more of an interdisciplinary approach. Resources depend not so much upon physical quantities, or even locations, as upon the technology used to turn natural human potentials into usable human talents. These resource technologies are physical, social, and economic. Techniques of management and social institutions must be developed. After all, our real concern is not with the quantity or quality of a resource, per se, but with its capacity to enhance the quality of life. In my view this interdisciplinary research approach may often bridge across the university. Other researchers beside those in the agricultural experiment station will be involved in rural problems. Likewise, experiment station researchers will be concerned with resource problems that involve urban people. We cannot preserve the obsolete rural-urban dichotomy when it hinders good research.

There are so many facets to this research area that I make no pretense of enumerating them all. Certainly I place human resources as the foremost area in which the land-grant universities must increase their efforts. Alternative types of solutions must be found to break the poverty cycle.

Work on water resources has been strongly encouraged all across the university as a consequence of the Water Resources Research Act of 1964. Research in outdoor recreation, forestry, land, and water use is growing at most stations. Several disciplines within agriculture are contributing to research on environmental health, which research is being financed largely by the Public Health Service.

Let me mention such other areas as farm policy, human migration, education and counseling of rural youth, school and local government finance, and community organization. These areas relate to a pattern for a whole new rural and urban social system, which is resulting from our revolutionary age. This pattern involves agribusiness, roads, zoning, churches, schools, and our towns and cities.

I don't have the time to discuss adequately our role in international economic development. The deep involvement of land-grant universities around the world is well known. The challenge is very great and, as yet, our response has been less than adequate. The immensity of the tasks is almost equaled by the difficulties of evolving new institutional relationships that will create effective and viable partnerships among those involved. I am certain that land-grant universities will be even more deeply committed in the years immediately ahead.

Lack of time forces me to omit mention of other important facets of the role of land-grant universities. Let me stress again my belief in the unique importance of our universities for educating tomorrow's scientists and for developing the broad scientific base from which can be launched tomorrow's programs -- whatever they may be.

DR. SEITZ: I will call for questions or discussion.

DR. BROWN: I am curious as a person who has not been involved at all with the evolution of our agricultural school. If today you were suddenly called upon to create something which would be the modern equivalent of the agricultural school, what do you think you would create, if you didn't know about the existence of the agricultural school of the past?

DR. ELLIS: As it developed?

DR. BROWN: Yes. Is what exists today, namely the way the agricultural schools evolved, a reasonably satisfactory institution, or do you think you would create something that is quite different and broader in nature?

DR. ELLIS: Certainly it is a reasonably adequate institution, as all divisions of our universities go. I would certainly do some things different. Of course I come from a prejudiced background. I was dean of an arts college 10 years with a competing dean of agriculture, so that I see things from some of that point of view, too.

Because for years agriculture was the only Federally aided division of the university, at many places -- and this varies with each

campus -- we did some things which I am sure we wouldn't do now if we were starting over again.

For example at our campus we had two departments of sociology -- rural and general. And this was foolish. It is bad planning. We don't have it now, except on paper. They are one department.

We have economics and agricultural economics. We have a department of botany in the arts college and of course horticulture and field crops in agriculture. I don't believe ours could be improved by being put all in one. They work closely together. The botanists are in the experiment station, although they are structurally in the arts college. But there are changes like this that I would consider.

I think most of us have gone over so much to interdisciplinary research, where we have agriculture in medicine, and agriculture in many of the arts departments, and agriculture in engineering departments other than agricultural engineering, working together on research programs, that I don't think whatever structure we have now in terms of departments and divisions would make any difference on that level.

DR. BROWN: You mentioned the evolution taking place on research and water resources, and then pollution problems and so forth.

DR. ELLIS: Yes.

DR. BROWN: Are you suggesting by this that the agricultural school might eventually evolve into what you might call schools of environmental sciences which would include agriculture and the whole multiplicity of problems involving man's place in his environment?

DR. ELLIS: I think something of this kind would be possible. As I look, for example, at our own work in environmental health, a great deal of it is in agriculture, a great deal is in medicine, some of it is in engineering, and some of it is in certain art departments. Those departments are primarily set up for instructional purposes rather than research. That is why we need cross-disciplinary research.

I can't see offhand any improvement that would come particularly that way. Facetiously I often tell the agriculture dean that it looks to me as if we have fundamentally three schools of business on the campus. One we call that, one we call agriculture, and one we call engineering. But I am not too serious in this, you understand. You still would have to have those. That is a convenient breakdown for instruction and preparation.

DR. RUTTAN: I think Missouri has done something that many of us have felt is very forward looking in the way you have handled your off-campus instruction and your extension. It seems to me that here you have gone further than any other school that I know of in bringing the whole university off the campus. I wondered if this has some relevance to the question asked previously.

DR. ELLIS: Possibly. We put together our general extension and our cooperative extension and half a dozen other smaller extension programs we had around, including one in medicine and one in each of our two engineering schools. We started with that, and then we acquired two more campuses--the University of Kansas City became part of the university system, and we started to develop a new campus in St. Louis. The whole off-campus program of all the campuses, as well as the cooperative extension, is administered as one unit.

You don't do this without some scars, because a lot of interests get involved. We had certain farm groups for instance that resisted this very strenuously. They thought the farmers were going to get the short end of the stick. They didn't think the rural people would get more by involving the total university, but that they would probably get less because we were going into the cities more than we had. But this unification and promotion on that basis has worked beautifully.

I think it is working well in many other places too, Nebraska, for instance, and West Virginia; and Wisconsin, I think took the move last summer, and Maine, and several other States. It is really working very well, I believe.

SECRETARY FREEMAN: I take it from your remarks that you feel you get a pretty healthy mix between research and training and teaching under formula grant programs. But under direct project grant programs, you just do not?

DR. ELLIS: No, we do not. Under the Hatch Act funds, we do. There may be an exception or two. I would say that virtually all of our research people teach half time -- half time on an experiment station budget and half on the teaching budget if they are any good on research.

SECRETARY FREEMAN: To what extent do you think there should be, if at all, an effort to stimulate and provide some of the programs into new and demanding fields? You touched on, I think very properly so, the area in which I am deeply concerned. We talk a great deal about the international food and agriculture problem, and the deep need of people for food is easy to see. But we tend to overlook what is going on in this country very fundamentally, of the basic adjustments.

Take a look in Mississippi today, the displacement of people, with no jobs, people with no education, who had a recent sit-in on an air field to kind of dramatize this. Look at it in the light of the people who are displaced with no place to go. And look at it from another extreme, at how as a matter of national development we are just bottling ourselves up in big cities at a frightful rate, and compounding

problems, in a country that is blessed with all kinds of space. A cold, hard analysis today indicates this is complete nonsense from an economic point of view; industry ought not to locate in New York City, or even in St. Louis, or even in Minneapolis. Most of them will be a lot better off someplace in a relatively rural area, just from the cold, hard-gut economic question.

All of this problem of space, space use, people and people displacement, alternative economic development patterns, new kinds of land use, the amount of research, applied recreation and its economic implication, the amount of research on this you can put in an eyedropper. I may be overstating this, and we have done very little of it within the Department of Agriculture, and there has been very little of it done within the whole land-grant college system, and very little of it done on an applied basis really in the whole extension system.

It is a real tough job to try to move anyone in this area for the reasons Dr. Ellis said, that when he tries to reorganize, the agricultural forces here are very sensitive and highly resistant.

I come back to my initial question, and that is in some of these areas, just as I would say in-house we have been lagging, I would say that the kind of automatic net result from the pretty picture that you have spun out here, just has not worked.

Do we just wait? This does catch up after a while, and you gave great leadership to this.

You mentioned West Virginia, Nebraska and some others. But we are way behind on this.

Ought there not to be a little use of not the stick but the candy to mold this? We can't wait for some of this adjustment. It comes too slowly.

DR. ELLIS: I think that rural development program, Mr. Secretary, did wonders for rural areas where we had the funds to put in. That moved a great deal. I would say it is the responsibility of the State university to do some fundamental research and to try to furnish the data for some real planning within the State. I can't go home and say there shouldn't be more industry in St. Louis, you know. This doesn't work. But I can go home and say there is an opportunity for industry in Springfield. That way we can do it.

DR. THACKREY: This is a sort of side comment, Mr. Secretary. I thought when we had the last White House conference on education, there was absolutely no discussion of the problem raised. I was shocked, frankly.

SECRETARY FREEMAN: There wasn't?

DR. THACKREY: None whatsoever.

SECRETARY FREEMAN: I wasn't there. Are you really saying now that you don't believe in project grants?

DR. ELLIS: No, I do believe in them. I think an essential measure of project grants is excellence. Where the Government is in need of research in a particular area, there is no better way to get information, to get research results, than to buy it in the best market and to buy it with a project grant.

But I will say that this is not a good way to develop a generation of scientists, for instance. I favor the institutional grant system, letting large institutional planning go on, and basing the institutional grant, in part at least, on the amount of teaching, directed to the number of scientists we are trying to develop on the Ph.D., master's, and even bachelor's level. I would let these influence the size of the institutional grant.

We had a figure given this morning of, I think, 20 institutions having a very large share of the grant money. They are not turning out anything like that proportion of Ph.D.'s in science. They are turning out a minority.

DR. BRADY: Yes, they are. There is a very good relationship between the number of Ph.D.'s and where this money goes.

DR. ELLIS: Your statistics are different from the ones I see. Not the numbers.

DR. BRADY: We both have to collect statistics. I think you will find a very good relationship between the two. Not between total students, but between Ph.D.'s.

DR. ELLIS: Ph.D.'s, M.S.'s, and Bachelors all ought to be included. My figures on Ph.D.'s are quite different than yours. I will be glad to look at them.

DR. CAIN: I want to ask if the planning in agricultural schools is taking adequate account of the following things:

First, an introductory course in agriculture for the liberal arts students which would be comparable to a freshman course in botany, chemistry, history, or some other introductory course as a part of general education.

The other is how much attention is being given to the education in agriculture of minorities? And I would like to include women here along with racial minorities. The reason for asking that question is because of the importance of both of these groups to international agriculture.

I have a feeling there is a deficit here, something that should be given more attention. I don't know whether I am correct or not.

DR. ELLIS: I don't know of any institution where they require the arts college students to take an introductory course in agriculture. I don't think this is educationally feasible. They require many of them to take an introductory course in economics where they ought to learn a lot about agriculture, industry, and a lot of our economic institutions.

DR. ALDRICH: I have explored in each State across the land what is taking place in secondary and elementary schools as well -- this business of producing some sort of agricultural literacy with respect to an increase in the urbanized population.

The upshot of it is, in terms of the opportunity for people not majoring in agriculture

in colleges or universities, it is a rare one that gives credit for or encourages non-agricultural majors to pursue any program in agriculture whether the college of agriculture offers it or not.

Increasingly in the areas of the biological sciences, in geography, in various areas of the social sciences, involving economics, anthropology, there continues to be really less attention utilizing agriculture as an example in these fields than there has been heretofore.

On the other hand at the elementary school level and the secondary school level generally across the country there is far better effort being made to provide some sort of literacy concerning the subject of agriculture and what it means insofar as food and fiber supplies for this country, or the implications in other aspects of the environment.

How do you inject into the new biology books a little bit about the importance of economic plants and animals rather than seeking or utilizing examples drawn from some sophisticated far out organism that no longer provides opportunity for people to be acquainted with the agricultural enterprise?

DR. ELLIS: Thank you.

VOICE: What about the minorities?

DR. ELLIS: I can't answer generally. I think they are well represented in our College of Agriculture the same as they are elsewhere in the university. I will say this, on this particular point: I think the best things in this area going on in our land-grant universities are our foreign students, many of them teachers of agriculture in foreign agricultural colleges, taking advanced work. They are making talks to student groups. They have a cultural association that puts on exhibits and has entertainments and programs talking about their own country and some of its problems. They encourage speakers to come out from the Embassy. This sort of thing is doing something.

DR. ALDRICH: I would like to comment about this, too. The land-grant colleges and universities -- I will take all the colleges and universities of this country -- are doing a very poor job insofar as accommodating minorities, at least insofar as they fall within low income groups.

I sat at a joint meeting of the Land-Grant Colleges Association at the AFL-CIO, which was sponsored during our Hundredth Anniversary in Washington, and I was surprised to hear labor say that the children of the blue collar worker today find no particular attraction, nor is there any given them. These are essentially white collar children's institutions and the laborer or the minority individual, which likely will fall into this class, does not find a place there.

This is the theme that is being talked about in the blue collar circles in this country today. And I know that as we have attempted to reach out to the Negro, to the Spanish-American in California, we find it very difficult to attract even those who have the wherewithal, the aptitude, the scholarship to move on to 4-year schools, however identified.

And the business of identifying in the elementary schools, in the secondary schools, those that have the capability, and giving them encouragement to move on to 4-year programs -- this is something that we must concern ourselves with right now. It is very difficult to reach out to these right at this point in time, because they see no opportunity for themselves following graduation.

DR. MC ELROY: President Ellis, I don't understand this. I thought it was against the law of the land. We just barely got integrated with respect to color and sex.

DR. ELLIS: To come back to that, I don't think there are many girls in the College of Agriculture, outside of home economics. We always have a few, but we don't have many.

DR. MOSEMAN: I would like to come back to the question raised by the Secretary with reference to research on problems of rural development, industrial location, and urbanization.

There has been a lack of attention to these problems. In the same way there is a lack of real resource development in the land-grant institutions for our work abroad. The question is how do we get the thrust to develop this.

The McGovern bill was designed to help build up our domestic capability. In the new International Education Act there will be provision to do the same thing, and there will be an amendment in the Foreign Assistance Act to do that.

I am wondering whether or not this is something for the land-grant institutions themselves, or whether the Federal agencies, or whether the combinations of the universities and the Federal agencies should really get behind these kinds of efforts to develop the capability to do these jobs.

This came home rather forcibly in our meetings in India where the five American universities operating over there made out that we have to infuse more science and technology into the development process. There is more or less unanimous agreement on that.

Then the question was raised: Can you furnish 10 people from the university, your university, and 4 others? Then we began to beg the question. We can get a few extension specialists, we can furnish a few professors on 3-month terms. This isn't adequate to do the job. And I think here is something that the Land-Grant Association and the AID, and possibly USDA and others, ought to get behind to be sure that we are getting this kind of a reservoir of resource to get this international agriculture job done.

DR. ELLIS: I have been well aware of this for a long time. It is a real need. I have noticed this difference: Once you get involved in a program, it improves a little as you go along. People with some experience abroad communicate this when they get back. There is

a willingness to go back if the institution treats properly the people it sends out. If they lose their place on the academic ladder, no one else will go out. So you have to watch this in the personnel administration, of your own university.

Another thing that I think helps is in the participation training. Members of the faculty get interested in these young men who are on the faculties over there. This is another encouragement. We need to do more than we have been doing. We have got to get more people abroad.

Of course you are caught as an administrator. I am speaking for a dean of a college of agriculture. He is short-handed anyhow. He is fighting all the time to keep staffed. He knows, you know, and I know, that you can't use all your people. You couldn't send them abroad. They may be all right at home, but they won't do in that kind of place. But we have to do more than we have been doing, no question about it.

DR. BRADY: At the land-grant meetings Dr. Byrd commented in his speech on the amount of research work going on in research development at the land-grant universities that it had increased only a very small percentage and, the fact that was pointed out at that time, it is surprising that it increased at all because over the period of time that he had his figures, funds coming to agricultural colleges from other sources than agriculture, from other sources than those that could supply this kind of money, had gone from essentially zero to about $25 million. And it was the only way this dean of the college of agriculture could keep a viable theme, by seeking the funds elsewhere.

In recent years they are beginning to get funds for the people in education, for the sociologists, psychologists, the kind of person that can devote his time to studies of people. I think we are going to see a renaissance in this. The social scientist -- the economist -- is finally coming into his own in terms of support for this. I don't think that the development of these programs at universities is accidental.

DR. ELLIS: I don't, either.

DR. BRADY: You can't do work in a vacuum. Where there are funds for this kind of work it is going to be done. I venture to say, Mr. Secretary, if there were $10 or $15 million from the Department of Agriculture specifically for this kind of work, you would see -- not from the Department of Agriculture necessarily, but HEW or anywhere -- you would see a complete renaissance, a complete redevelopment of our whole attitude toward research and what comes out of the universities -- the kind of trained people in this area, people-oriented in research education.

DR. ELLIS: We have a new research program in this area, but it is in the research group. It happens to center there because we have a live-wire who was interested and got some money. We put in some also. And that was it.

SECRETARY FREEMAN: Let me comment on what you have said. This assumes of course that everything that we have been doing should continue to be done forever, and that there is nothing by way of what you are currently doing which has a lesser priority than what we just talked about that ought to be done. It just means that you pile on the pyramid.

Frankly, we get into some in-house complications right now that are budget-oriented, obviously, but this is a bullet that you have to bite. One of the things that the President has said in a very tough-minded way is that you have to order your priorities, and you have to see if there are some things along the road here that you no longer need, or that it would be desirable if there is something else that perhaps has a little higher priority, and be willing to do this.

Speaking about research a moment ago someone said there are some research facilities around, quite a number, that are too small to be effective or efficient. Let me tell you something. Try to close those facilities, and you will get a lot of trouble. This is a problem.

DR. ELLIS: The president of the land-grant college has the same problem, and he knows exactly what you are talking about.

SECRETARY FREEMAN: You are absolutely right. We do have to really do some hard thinking, because the pot isn't limitless. You have to take some off the bottom as well as put some on the top.

DR. MEHREN: I am very much puzzled because this morning and this afternoon almost without exception everybody in this group wants to do good and do right, and perhaps do well. Everybody wants to be for the people, and everybody wants to use food aid as a means of generating economic growth elsewhere. Everybody is in favor of generating growth in areas or among occupational or racial groups that are depressed here. But the cold fact is there is no research to my knowledge anywhere in the areas of any type of development -- foreign, domestic, personal or human, or resource development.

If you use the word "research" in the usual logical, positive sense, of developing a hypothesis and testing it, there are no theoretical constructs to my knowledge from which you can really derive testable hypotheses as to the generating causes or relationships of any kind of development.

In the absence of that kind of a hypothesis then -- the best usually applied to it -- there is no research. The consequence is that in credit programs, in electrification programs, in telephone programs, in housing programs, in domestic development programs, and especially in the foreign food programs, we are, in fact, operating on an ad hoc basis. In fact, if there be any guidance from research

which specifically identifies the possible means of achieving your objectives, I haven't seen it.

It seems to me if there be one hole in this discussion, or theory, as a means of constraining your hypothesis to a workable small number, where research, systemed to give you guidance as to how to operate a program is needed these are the fields. And again to my knowledge, professionally, there is a total absence of anything that could even crudely be called research in this field.

DR. SEITZ: Ted Byerly has a question. Then we will get on.

DR. BYERLY: For about 5 years now we have tried to call attention and have called attention to the Secretary's report -- Lyndon Johnson's report to the land-grant colleges. One of the advantages of support is that each individual director has a wide latitude for selecting those areas which he will support.

Mr. Secretary, the director is subject to immediate constraints. He is rather closer to the people of his State perhaps than the Secretary of Agriculture is. So not all of them have responded.

I don't quite agree with George Mehren because that body of information which has been collected in such institutions as the Missouri station I would rate as research. He is being real purist and said it isn't research; we have to do better. This is true.

I would point out that one of the advantages of the formula funds is to get it in the hands of those who will and can recognize and support this kind of work, and it isn't quite so subject to local pressure.

President Ellis knows what I say is true because he has supported at least the gathering of information in this area, and so have certain others. Including, for example, the Mississippi Agricultural Experiment Station.

SECRETARY FREEMAN: I don't quite understand you, Ted. What are you saying? That if there is not response to new conditions, because of inbred local lack of leadership or of strong conservatism, that therefore we bow down to the goddess of local direction and say there is no problem?

DR. BYERLY: There is written into the Hatch Act that it shall be responsive to local needs. This is true. I pointed out the Mississippi station; the good lady who has done this kind of research in Mississippi retired last year. But they have continued through thick and thin to do what she called research.

It is true, as George has pointed out, that testable hypotheses are difficult to come by because you don't do experiments with people. It is socially frowned upon. This does enter a kind of difficulty. If he thinks he has a hypothesis I wish he would get up and give with it because we do need some.

As far as the will to do is concerned, there is some will to do in this area. There ought to be more of it, and the directors have it within their capacity to do more of it if this is high on their priority with formula funds.

SECRETARY FREEMAN: Why isn't it high on their priority?

DR. BYERLY: Each one will have to give an answer for himself.

SECRETARY FREEMAN: If they don't do it, what should we do about it?

DR. BYERLY: What should we do about it, sir? The alternate would seem to be to provide, as here suggested, funds in the Department of Agriculture's own budget for grants in this area. I would point out to you, sir, that there are priorities for new research. The small agency I head has $25,000 earmarked for it. We will see whether it survives.

SECRETARY FREEMAN: We are trying that in Extension, now, and running into criticism.

DR. SEITZ: I think we had better go to the next speaker or he won't make his 7:00 o'clock plane.

The next and last speaker--formal speaker--on the afternoon program, is Chancellor Aldrich of the University of California, Irvine. He was previously dean of agriculture at Berkeley, and he started his professional career as an expert in soils and plant nutrition.

He will speak on Research in Agriculture: A Key to Understanding Our Environment.

AGRICULTURAL RESEARCH: A KEY TO UNDERSTANDING OUR ENVIRONMENT

By Daniel G. Aldrich, Jr., Chancellor, University of California, Irvine

It has become reality to talk about a world of 3 billion people. It seems appropriate then to give some thought to an accompanying reality -- not just the distribution of calories around a crowded world, but the total impact of people on the land, the air, the sea, and all other resources of our environment.

We can guess that a few hundred millenia ago, man left his environment pretty much alone. If we don't want to go as far as to say the environment created man, we can surely say that he held his own as a species because he was an adaptable organism. He could live in the environment he found.

We've come some distance from that beginning. It is one of our definitions of man that he is distinguished among the species by his ability to modify his environment.

In this century, of course, that ability has become all too obvious. In some cases man has modified his environment within an inch of its existence -- and his own.

Our cities made of freeways, parking lots, and a hundred miles of subdivisions are massive modifications of the land and nature. So are our great buildings and bridges, our parks, our cultural life, and our universities themselves. But these monuments to our capacity to modify the world are themselves results of man's ability to select seeds to grow and animals to feed and milk, of his ability to move water to plants, and to nourish them with fertilizers. They are results of all man's inventions that have given him more food, clothing, and shelter, and have let him multiply.

The basic modifier of nature is agriculture. And behind change there must always be experiment.

The first cliff dweller who saved seeds from his biggest head of grain for next year's planting was a straight-line progenitor of today's geneticist -- an agricultural researcher. Today's seed selection may be a little more sophisticated. The researcher understands genetic principles and he may choke the computer with a lengthy formula. But the object is the same.

The brother of our cliff dweller who found he could eat all winter if he saved his seeds in a cool dry place -- he was an agricultural researcher too. Today, agricultural scientists are searching more than ever for ways to save the foods we grow for future use. The research tool may be an 11-foot pit, lined with heavy concrete and lead. At the bottom, under water, is a dangerous object -- cobalt -- that gives off gamma rays. Only a flat of strawberries being lowered into the pit for exposure to the rays tells us this is agriculture. But its objective is the same -- finding means of keeping perishable foods longer.

An engineer may turn his experiments toward fundamental laws of inertia. But from his knowledge may come a machine that will shake a prune tree just enough to drop the fruit into a catching frame and not enough to hurt the tree. The fundamental study of a physical principle may also be agricultural research.

We may find a forester driving 5-foot tubes into the earth around a 2,000-year old redwood tree. He lowers a neutron-emitting device to the bottom of the tube. Instruments then count reflections from hydrogen atoms in the water molecules stored in the soil. Here, nuclear science measures the moisture supply of Sequoia gigantea and gives us new knowledge of an ancient part of our environment -- a forest that was mature centuries before the Christian era. The nuclear device in the tube in the forest is an agricultural research tool.

We may see a crew of workmen building a concrete dam across a dry streambed. Above the dam, brush and excess trees are cut or killed with chemicals, the watershed is burned, and the land is planted to grass and clover. With the dam, scientists can measure the flow of a creek that is no longer dry. They learn how much water brush and trees transpire. Fire, the ax, and a dam on a dry creek are tools of agricultural research.

We may find a scientist and a technician piling grass or brush under a metal structure that looks like a giant Indian teepee. Then they set the pile on fire. This is agricultural research, too. Instruments at the top of the teepee measure gases given off by burning grass, straw, and different species of brush. As a result, the contribution of agricultural burning to atmospheric haze and smog becomes a scientific fact rather than an accusation.

In another laboratory we find a researcher carefully measuring drops of a solution into a tank of very small fish. The scientist uses them as a biological measure of chemical toxicity in an almost unmeasurable amount. The fish, too, are research tools of agriculture.

In a white-tiled laboratory the nearest thing to nature may be chlorophyll in a glass tube. The scientist is concerned with the flow of electrons in the steps of photosynthesis. But this is agricultural research. It yields information on life's processes for deposit in the bank of basic knowledge. Agriculture's increasingly sophisticated problems can be solved sooner because this bank of research knowledge exists.

Agricultural research has indeed become a sophisticated enterprise. Its gamma ray food preservation, its neutrons in the forest, its delving into the functions of chlorophyll and DNA -- these are as "far out" as the advances of other sciences toward understanding of the mind or the moon.

But problem solving has not been forgotten by those who set the course of agricultural research. Problems may be more complex. But complex methods of problem solving

match them. And researchers in agriculture are leaders more often than followers in science. Other segments of the universities are only now coming to grips with a problem-solving dilemma that was met by agriculture decades ago.

The modern research device in our universities is the research institute. But the agricultural experiment station, which has been around so long it is taken for granted, is exactly such an institute--a problem-solving agency created to fulfill a special research mission of the university.

That mission might be summed up as a threefold one:

First, to exploit scientific discovery from any and all sources that can be applied to problems of agriculture, technical and practical;

Second, to undertake direct problem solving for agricultural industry; and

Third, to engage in basic research in areas where technical advancement of agriculture is most likely to be limited for lack of basic knowledge.

It's not hard to see, of course, that these research interests may pull in opposite directions. Search for basic knowledge demands specialization. And the larger and more complex the university becomes, the more specialized its fields of research are. While the most progress can come where there is high specialization, problems come with it too.

The forces of specialization are highly centrifugal forces. They tend to throw the university apart. They separate a researcher from his colleagues. The trend is strong in a large science-oriented university such as California. There has to be some integrating force.

With just that aim, many American universities are now creating institutes or centers. In these they can reassemble the specialized scientists into problem-solving groups.

Our Water Resources Center in California is a typical one. This is a university-wide agency. It cuts across lines of departments, colleges, and campuses. Water is obviously a key interest of agriculture and agricultural research in the West, and the director of the center was drawn from our department of irrigation. But attached to the center through mutual research interests we have engineers concerned with conversion of sea water, hydraulics, and sanitation, agricultural and non-agricultural economists, marine resources researchers, and representatives of other disciplines.

The university-wide center follows a pattern of organization pioneered in the college of agriculture departments of any land-grant university. A department of animal husbandry, agronomy, or vegetable crops, for example, is an assemblage of highly trained experts--geneticists, physiologists, nutritionists, and biochemists--into a problem-solving team. The agricultural experiment station is itself a larger problem-solving team.

A look at projects on the books today in any State suggests a scope of problems beyond the dreams of those who devised the agricultural experiment station. Today, I believe we can say that agriculture's problems and the research that aims to solve them spread over the whole span of man's involvement with the world he lives in.

Some hints of this show in the colleges' recent reappraisal of their names. Michigan now has a college of agriculture and natural resources. Rutgers, too, is broadening its name and will have a college of agriculture and environmental sciences. Texas is adding a school of natural bio-science to include departments of range science, wildlife science, and parks and recreation.

The outreach of agricultural interest has long passed the old lines of production and marketing to areas that were remote from agriculture a generation ago.

Agriculture and its involvement with the pressures of people on the world's resources simply cannot be separated. This involvement will grow because the pressure of people is surely growing. Secretary Freeman noted in one of his recent talks that, even in the United States, this pressure is growing at the rate of five persons a minute. In a year that rate means 2 million 600 thousand more persons competing for parking space and lanes on the freeways--competing for Class I farmland to grow houses and garages, shopping centers, and factories--competing for elbow room by a fishing stream and for a trailer stall in a national park.

People are already competing for water to drink and bathe in. Even in this well endowed country, people could compete for food, except for the phenomenal success of agricultural research.

The agricultural abundance that makes a hungry future look so remote in the United States has been almost an embarrassment. But it is continuing evidence that the science of agriculture is the science of conservation.

The technology of agricultural abundance has freed men's hands and their inventive enterprise. Conserved energies have created our automobile industry and its roads, our dams and electric power, the electronics industries and their refinements of living, even the air conditioning that has made summers more livable.

Especially, abundance has freed the time of people to enjoy living and to concern themselves with nature and preserving nature. We find nationwide interest now in all of our resources--our mountains and forests, our streams and lakes, and even occasionally our farmlands. These all are our concern, largely because agricultural research in this country has solved the problem of feeding and clothing people.

But even in solving an agricultural problem, the research may have marked influence on our total environment.

For instance--consider our rangeland specialist measuring the flow off a watershed he has converted from brush to grass and clover. He may think of livestock, water, or irrigation of the farmland below. But when he has converted worthless, impenetrable brush

to grass, he has created a resource for deer and birds as well as cattle. He has opened up new space where urban people can hike and hunt. He has conserved water to fill streams and lakes, where fish can live and be caught. And he has brought open beauty to the landscape. Agricultural research that has taught people how to improve wildlands has paid repeated dividends in conserving natural resources for the public.

The agricultural engineer's basic studies of physics may lead to a machine that will harvest tomatoes, or lettuce, or olives. But there is a social and economic contribution, reaching to people well outside of production farming. The machine may save an industry that might not survive labor scarcity. It conserves manpower and also human dignity by making better jobs -- jobs that call for higher skill and higher pay. A new farm machine creates jobs for the men who build it, too, and the economic lift of new wealth in a community.

The inventiveness of the agricultural research worker is translated into benefits for people who may themselves see no connection with agriculture.

Research scientists irradiating a crate of strawberries may be running one of agriculture's far-out experiments. But they may, in this or other research, find the key to long shelf-life of fruits and vegetables harvested at their peaks of ripeness. This is resource conservation in one of its highest uses, research to preserve the product of the soil from waste and bring it to the table at the highest point of quality.

An agricultural scientist seeking out the components of smog, or measuring toxicity of a new chemical in parts per billion, concerns himself first with agriculture. Smog plays havoc with the tender leaves of vegetables and other products of the farm. It has been an incidental benefit, too, to know that agricultural burning is itself a very minor smog maker. Finding what chemical residues, in the most minute amounts, may do to living organisms is of first interest to agricultural users of chemicals.

But the atmosphere and soils and water are some of the most obvious components of our public domain. There is no one without a stake in agricultural research that concerns itself with pollution of any kind -- by waste gases, liquids, or solids or by any of the inevitable by-products of modern living.

I believe the direction signs for the future in agricultural science are clearly posted. The soils, the water, the atmosphere, and all that grows in this environment -- cultivated or in nature -- are inseparately involved with agriculture in its narrow sense and with agriculture as the environmental science.

Our national and international policies demand that we harness science to economic and social development. We see national commitment not only to goals of better distribution of wealth and income but to more beautiful surroundings. It is our national intent that the environment we live in should do more for people than feed, clothe, and house them.

In the last annual report of "Resources for the Future," that organization's president, Joseph L. Fisher, expressed some thoughts that are certainly pertinent here. He said:

> We are entering a period in which people generally will be deeply concerned with how natural resources and the natural environment are used. Merely getting enough cheap food and materials will not be enough; people will want to be sure that the quality standards are established and enforced in terms of water and air purity, landscape protection, and the physical and psychological health of human beings. The public interest clearly must embrace quality as well as quantity in the matter of natural resources.

Obviously, the problem we're talking about is not a great deficiency in production research -- the kind that will bring us a better carrot or more carrots, or even the sophisticated development of machines that will harvest grapes or strawberries. In the larger area of agricultural research embracing the total natural resource, the essence of our need may be in the economic and social sciences rather than in the more familiar natural sciences and technology.

But if the historic emphasis of agricultural research is shifting or expanding, what about the clientele? Is the agricultural scientist talking to the same people who listened to him when he confined his attention to new hybrid seeds, new water uses, new fertilizers, and other aspects of research to make crops grow and grow better?

I think not. At least agriculture should be talking also to a new clientele as research turns to problems that call for the expertise of social and political scientists.

In farm production, processing, and marketing, there has always been a ready clientele or public to work with and for the testing and developing of research ideas. Engineering research and development has always had its clientele in industry. Medical science in the university laboratories and hospitals has its responsive client in the medical community.

But when it comes to applying research in the social and political sciences, there is no ready bridge to the clientele. Our new clientele, in fact, may well be the whole world. So, our ability to apply what we already know to the problems of total resource development is exceedingly limited.

Some directions of research and action on the problems of our environment almost point themselves out. We hardly need look to find one near at hand, where the Potomac estuary carries off the wastes of 3 million people and their industries. Sanitary engineers have raised the level of waste treatment, but increasing population has offset the improvements.

We are too prone to count on natural dilution to solve our problems. The Potomac Estuary has been overwhelmed by the volume it has been asked to dilute, just as the air over Los Angeles has been unequal to the burden of hydrocarbons poured into it from automobiles. And if metropolitan Washington has a problem, so has California's high Sierra. Six thousand feet up in the Sierra, the blue that made Lake Tahoe famous is threatening to turn to an algae green as the wastes pour in.

We can look beyond the land itself and find a ready problem of conserving and developing the world's natural resources. The oceans are no longer something apart. Marine resource scientists can find DDT and its metabolites in fish and shellfish over half the Pacific -- in samples taken from Seattle to the Gallapagos and from San Francisco to Hawaii. It is clear that pollution of water as well as air poses an international drift problem. Chemically, at least, we have become one world.

It's no solution to say, "Limit the people." Or, "It's too late." The problem is here now. We know, or are well on the way to knowing, techniques that can solve a lot of the problems of water pollution, air pollution, and resource conservation and use. But still we fall short in learning how to organize people to be problem solvers.

I am not discouraged about our eventual progress, just as I am not ready to concede the hungry future we hear described so often.

As recently in our history as the early 1930's, a few scientists who worried about this country's loss of topsoil were simply voices crying in a wilderness of disinterest. Farmers were barely aware of their own problem. If they were, they knew little that they could do about it. City people cared less.

Today, across an increasingly urban country, soil conservation is almost a social movement.

I think agricultural research is well tooled up. With our bank of past research and a coming flood of new knowledge in the biological sciences, our working material is not a problem. Our systems experts with their computers can give public and private administrators technically sound and economically feasible choices for handling a problem such as a river or a watershed. We can project the extent of resources and the population pressures on them into another century.

I am convinced that agricultural research, which has responded successfully through all of its history to the needs of people, must find the means to meet their broader needs today.

The pressure on land and the total of our natural resources is intense and growing. The agricultural problem solving philosophy that brought overwhelming abundance is capable of the same success in new directions.

If agriculture is going to solve the problems that are paramount ones in today's world -- at home and abroad -- agricultural research must, I believe, apply its historic energy and inventiveness to the social and political sciences.

Research in these fields will produce more insight into how the public interest in planning and developing the environment can be determined, and hence find deeper understanding of which policies and which programs can be the vehicles for carrying forward the public interest.

In summary, agriculture can and must find ways to meet the challenge of resource development in a manner that will fit the needs of our rapidly urbanizing society. The development of our Nation's resources has many economic and sociological problems. It also offers opportunities to both rural and urban peoples.

Agriculture must provide the leadership necessary to create an awareness of the basic problems of our environment. It must provide factual information on which wise decisions can be based, and it must stimulate interest and participation by citizens in developing and implementing a positive resource development program. Such a program must be consistent not only with our overall national goals, but also with the goal and welfare of the agricultural enterprise.

DR. SEITZ: Thank you very much. Are there any comments or questions?

DR. WENK: It seems to me that Chancellor Aldrich has said something terribly important here today about this matter of putting together problem-solving organizations. There are two qualities to this that bear on the general topic that I have heard discussed that may be some kind of a clue toward some of the questions that the Secretary has asked and that George Mehren has pointed to in discussing the relative lack of a systems approach and research to some of these broader questions.

It strikes me in the first instance that when we talk about problem-solving organizations, we have to recognize that there are several classifications of problems, and this is one of the things I heard Chancellor Aldrich say.

A multi-disciplinary approach is needed, to be sure. But there are multi-disciplinary approaches to scientific problems, and I think there are multi-disciplinary approaches to problems in technology.

We haven't heard the word technology very much here today. It is almost like the word "comrade". It sort of ran down hill, and people don't use it very much. Yet to me the word "technology" describes a focus on the social needs and the techniques of bringing together and mobilizing what we can derive from science, together with economics and sociology, and I also haven't heard here today about public law, because we are doing all this in the context of a public institution.

Some of us who are in this new area of science policy research learn soon that the scientific ingredient constitutes only maybe

20 percent of the total. But the problem of bringing together people from different disciplines to work at this upper level of a multidisciplinary approach to problems is exceedingly difficult.

I would suggest that one of the problems lies right in the university. We complain about the way our bureaucracy is highly structured and the need to coordinate our different agencies. But I have yet to encounter a single university where the departments speak adequately to each other.

We also have another problem where we have given great credit to career development as a specialist, and we as a society have no way of rewarding the generalist. We are beginning to admire versatility, and we require it more and more. And we now even have a cute way of saying that we are not interested in what a man was trained as, we are interested in what he is working as, suggesting that there is some mobility here between fields. But we somehow or other have missed the point that in this very complex world, where we realize that the problems are no longer one dimensional or even two dimensional or whatever; that we haven't built a problem-solving organization or problem-solving attitude that will deal with this complexity.

What I have come to admire here today, in hearing these discussions, is that the field of agriculture really does provide somewhat of a model. I must say I was skeptical when I heard some of the people saying this earlier. It sounded, if I may say, a little self-serving. But I'm convinced that this field has been the beneficiary of this kind of approach. This doesn't say the field doesn't have problems.

Whether or not the universities can face up to this multi-disciplinary approach to this problem solving depends on how much fertilizer you bring to the problem, and this fertilizer is a green kind called money. And this does constitute a problem.

With regard to the matter of looking at land use that the Secretary mentioned before, I was quite shocked to find that the total research budget for our new Department of Housing and Urban Development for the next year is $750,000. And of that, most of it is earmarked for marketing research having to do with real estate. This is not enough money even to look at the problem, much less seek solutions. And I rather feel the same problem exists today with regard to some of the complex systems overseas where we are going to try to adapt our science and technology to this problem of over-population and malnutrition. But to do this I think we have got to recognize that you need first of all this attitude toward problem solving on the one hand and some source of funds on the other. And it may be that a meeting of this kind can find some ways of getting at these two deficiencies.

DR. SEITZ: Ed, after you have got the Federal government in order, society will let you try to put a university in order.

DR. PRICE: It will serve him right.

DR. WENK: I have no illusions about the first.

DR. BROWN: That will take a little longer.

DR. MEHREN: Do you think that the proliferation of centers, like the water center, which served us for a long time, center after center after center, generated because the old line departmental organization can't put the bodies and skills together to engage specific design problem work? Does that mean in your judgment that we ought to be looking at the administrative structures of the universities, the research operations, just as we might be doing that inside the department?

DR. ALDRICH: I would answer your question this way, George: In some instances the creation of an institute or center may provide a vehicle for interdisciplinary approach to a problem that is not accomplished across departmental lines. But I am really far more impressed with the notion that the creation of a center or an institute provides a vehicle for the attraction of resources that would never be given to an old line department. But by being able to package their interdisciplinary effort in terms of a center, you can get support. People who have resources in terms of these want to know where the money is going -- that it is used for this purpose or that, and an institute so defined accomplishes the job.

DR. MEHREN: May I ask you, what line would you take from the building of a university from nothing up to 20,500 kids, and a city around it? Why didn't you organize along departmental lines as the mother campus did for hundreds of years?

DR. ALDRICH: I was trying to avoid the problems of the mother campus and the rest of the institutions that have been generated over hundreds of years, the problems of crossing departmental lines. Therefore, one start was, don't create them.

My greatest problem right now is to make sure that a year out, the divisional structure which we have created, which involves five areas -- social science, biological science, physical science, humanities and fine arts -- does not itself create some sort of dispute that prevents or reduces flow of information across the lines. This to me is our greatest problem in this new enterprise. The only thing I can suggest in a practical way now is that I have indicated to the faculty that each year we are going to assemble in a big field; I'm going to blow the whistle and yell "Regroup."

DR. UPCHURCH: Dr. Seitz, I have been both delighted and embarrassed many times today. Delighted by the many references to the importance of social science research in the whole field of agricultural research, and embarrassed by the fact that the social scientists generally don't have more results to show in this whole general field.

Particularly, Dr. Aldrich, I was intrigued by your comments on the clientele that other disciplines seem to have, and the lack of clientele that the social scientists seem to have.

What comment would you care to make to this group on how we might marshall, or how we might look for better support of our social science work in its niche in the whole field of agricultural research.

DR. ALDRICH: I'm not going to be able to pour forth a great deal of wisdom because this enterprise on which I am embarked or involved is a great educational one for me. But as I look upon what we are trying to do -- and essentially we are trying to devote the aspirations, the goals, the objectives of a whole institution toward the concern, the affairs of man in the environment, in the matter of human ecology -- I would simply indicate that in developing a clientele -- I feel we don't have one -- the agriculturist turns to the farmers. Those in the social sciences and political sciences by and large on our campuses, I feel, have written for their own interest and stimulation. Our colleagues in the field by and large have not chosen to frame or communicate their ideas to people in a communication -- I don't care whether the community is at the door, across the street or across the nation -- in a fashion that they understand.

Furthermore, until recent times I do not think that there has been a concern by the citizen for reactions to the ideas generated on a campus. But I'm impressed today that there are mechanisms evolving out of the society, out of the public. I don't care whether it is planning economics or projects concerned with urban renewal or renewal, or the one we are setting in Orange County -- how to set this county planning toward the 20th Century.

These are blue ribbon committees made up of blue ribbon citizens but terribly uninformed about how to do what they hope to do about the environment. It is a case of the halt leading the blind, needing desperately to be in touch with the experts that are developing or have developed on campuses across the country, yet not knowing how to reach out to get hold of them. In turn, the expert on the campus, I feel, is not particularly articulate in communicating to these folks the things that they ought to be concerning themselves with.

But the fact that campuses are steering in this area, are showing concern, the fact that John Doe is expressing concern, to me provides the environment for the first time where these can come together.

This is what I'm striving to do in our particular situation. Fortunately I have two young men, one a dean of social sciences who keeps beating away on me: "Dan, for heaven's sake don't think that the social scientists yet have developed the tools that enable us to respond immediately to the problems the community presents to us."

We are beginning to get ideas, but Jim March is so concerned that they still have opportunity to build the tools that may one day be meaningful to the community.

On the other hand a man responsible for our professional school of administration, Dick Snyder, recognizes that at least in his design of this school, his development of it, that there must be involvement of the community with his people, input from the community. Between James March, who holds off saying you don't have the tools yet, and Dick Snyder being willing to take such tools as we have and relate them to communities, I think the bridge is building.

DR. UPCHURCH: Pursuing this further and harking back to our delightful seminar last night, I think the social scientists are going to have to be increasingly called in the social engineering problems, call them planning economics or whatever you will. Can you bridge the gap between the social scientist on the one hand and the physical scientist on the other?

DR. ALDRICH: In my system, yes. And it is as simple as this. I had the opportunity to start from scratch. I didn't inherit a soul. It was possible for me to reach out to men who had demonstrated that they were stimulated by, and as a consequence of, reaction with people, the public, the community, the man in the environment. Their researchers moved forward in better fashion than walling themselves off from the realities of the environment.

There is no question of the response of some of the people we have brought to this particular campus to the community in one man's instance, which will be somewhat greater than in another. To the best of our ability we have sought those who are stimulated by the notion of relating to some of the problems we face.

DR. UPCHURCH: You have a unique and fortunate situation.

DR. ALDRICH: I know.

DR. UPCHURCH: In some of our older institutions, our county agents, your county soil conservationists, forest rangers, many others, are all getting involved in the social engineering problems. And somehow I think we in the educational field generally -- thinking of both the Department of Agriculture and college people generally -- somehow need to reemphasize our in-service training of these people to better prepare them in this whole general field.

DR. SEITZ: Dr. Murdock?

DR. MURDOCK: I would like to say that it seems to me entirely fruitless to argue how good, bad, or indifferent the social sciences are. We are historically later than others. We are numerically smaller. We know our strengths and our weaknesses. Unfortunately the weaknesses are what we are most aware of. It seems to me that judging by past experience, every time the social scientists have taken the initiative and have tried to sell

themselves to government agencies, they practically always have fallen on their face.

On the other hand, I can cite a great many instances where agencies have come to the social sciences with problems and the social sciences have been able to make some definite contributions.

I would say, for example, that when the Navy took over the administration of the Trust Territory of the Pacific, they sent out 40 anthropologists, geographers and others to study the native culture so that they could adapt their administration to them. This happened to be the kind of thing this particular social science can do effectively. The result was, I am convinced, the best colonial administration in history for the period the Navy conducted it.

So I think that you should not ask the social scientist to come forward and say we want to get in the picture; we think we can help. We would much rather that you work, let us say, through the National Academy of Sciences, National Research Council. When you have problems which you think probably we can help you on, approach us. We will tell you frankly what we can and what we can't do. And sometimes we will be able to do something effective.

DR. ALDRICH: In thinking on this -- and I should not prolong my own departure, or yours, either -- I am convinced that agriculture went through this very same evolution. We are aware, as the first chemists and geologists and mathematicians applied themselves to the problems that confronted our nation a hundred years ago, of the derision which was heaped upon the hothouse farmer, the man who expressed himself in terms of the science of chemistry, physics, or what have you at the time.

But we have learned over a period of time how to communicate. And I simply feel that this is part of the problem we face as we move into extending agriculture into these other areas. Social scientists, political scientists will learn how to communicate, and in turn people will be able to indicate more precisely what their needs are. We have collapsed a hundred years of experience into this discussion with respect to agriculture.

DR. RUTTAN: I think the social scientist, particularly in the Department of Agriculture, needs a little defense at this particular time. When I worked at the Council of Economic Advisors, it was apparent that there was only one agency in government in which the professional economic staff could give their Secretary the consequences of economic policy, could estimate the consequences of economic policy accurately -- that is, any agency within the Department. The Council fortunately was able to do this in the area of monetary fiscal policy. It was only in the Department of Agriculture that you had the staff coming to the Bureau of the Budget and the Council as a consequence -- the income consequences, the budget consequences, the production consequences -- of the economic policies being proposed. The Department of Interior couldn't begin to approach this. The Department of Commerce couldn't. Treasury does quite well. I think that the traditional research built into the Department of Agriculture has paid off very handsomely not only in the biological sciences but in the social sciences.

I hate to be in the position of a social scientist defending social science against charges of lagging. But I think Northrup Yale wrote about 25 years ago that the social sciences conceptually were essentially ahead of the biological sciences. And working closely with a group of biological sciences at the International Rice Institute, I am convinced that if we had an adequate theory of plant-soil relationships we wouldn't have to do fertilizer tests over and over again.

DR. SEITZ: It is now 5:30. There will be plenty of time for discussion in the hours ahead. I would like to suggest, with your approval, that we adjourn for the afternoon.

[Whereupon, at 5:28 p.m., the symposium was recessed to reconvene at 8:30 p.m. the same day.]

EVENING SESSION (Thursday, February 24, 1966)

DR. MEHREN: It has been a very good day. We have had some excellent battles; we have had some rather good slugging matches. I think if I learned anything at all today, the first thing is that there really isn't any great difficulty in a physicist talking to a biochemist, or a biochemist talking to a statistician.

Now we sort of put the top on the day. We have a gentleman from Kentucky, Don Price, who is dean of the Graduate School of Public Administration at Harvard University.

He came from Vanderbilt University, a neighboring State as States go in that part of the checkerboard cosmos of the United States. He has been a pleasant chap today. He has been no less and no more contentious and argumentative and difficult than any of the rest of us. He is a Rhodes scholar, which I presume means that once in your life you had muscles and reflexes with quick reaction and also a sharp and bright mind. That follows, doesn't it?

DR. PRICE: No, but go ahead.

DR. MEHREN: And he is loaded with degrees, of a sort. I think, seriously, Dr. Price has held as many really interesting and different kinds of jobs and assignments as anybody in the group that has been fussing and arguing today. He has been in the Government. He has done a great many different things in the Government. He was on the Ford Foundation for 6 years. He served as vice president for a long part of that. And he has been at Harvard as dean of the Graduate School of Public Administration.

He has done some things that even I have read. He has a book on Government science, and I read it. That was written 12 years ago. One of the things that book did was talk about the impact that science would have on public policy, and to put it mildly it was almost as provocative as most of the discussions we have had today.

He has done another one which was called "The Scientific Estate," and it, too, to put it mildly, is provocative, and the reviews are provocative. It is good work. It is a good essay. And it is a beautiful job on constitutional theory. It is original, broad; it is imaginative.

I think this is the first time a man who is not a life scientist or a physical scientist is a president-elect of the American Association for the Advancement of Sciences. We have made our jokes and we have had our fusses today. This, I say in complete sincerity: We are honored; we are pleased, to hear what you have to say, Dr. Price.

THE AGRARIAN TRADITION AND THE NEW SCIENCE [1]

By Don K. Price, Dean, Graduate School of Public Administration, Harvard University

I think I am here today because I got in trouble about four or five months ago. I was asked to speak at a seminar at the Brookings Institution and I was told the difficulty about these seminars was that people tended to go to sleep after dinner, and I was to try to stir them up a little bit. And so I made a few incautious remarks with that purpose. There was no bother about it at that dinner, although Phil Handler, who unfortunately didn't stay for this evening's session, was a little bothered by a few things I said. But this would have passed if I hadn't had the bad luck to have the editor of Science Magazine there, and he insisted upon publishing the talk.

My secretary said two days ago, "I hope you don't have another talk published. If we have any more letters of protest from the land-grant colleges, I will never get any work done around here."

And I rather suspect that Ted Byerly, my good friend, noting that I said in that particular article very incautiously that the Department of Agriculture had had the misfortune to get frozen with an obsolete pattern of research support, wanted to ambush me here tonight, and so I am confessing in advance.

I did indeed say that, and I deeply regret it.

The regret isn't on account of my secretary, of course, but mainly because it misrepresents how I really feel about things. It might be different if I were a scientist. But I am not a scientist; I am an old hand in Government and public administration, and a professor only recently.

In the time during which my point of view was really formed and my opinions frozen -- that is to say, nearly 30 years ago -- I really almost worshipped the Department of Agriculture.

In the late New Deal years when I was working in Washington, there was no man to whom we bureaucrats (including stray professors of political science who came to Washington to learn about what was going on) listened to with more attention and more respect than Bill Jump. Names like Jump and Stockberger and M. L. Wilson represented to me then the very top of the business that I considered the most important in the world. I am not sure I was wrong, either.

This was because for any of us who came to Washington in the atmosphere of the 1930's, it was very easy to feel that American society had fundamentally gotten off the track a century before, that the strength of the great industrial corporations had come to dominate our politics more than it had any right to do, and the world of agriculture seemed still to represent the early Jeffersonian dream.

Here was a separate part of society, with its own civil service, so to speak, and its own educational system, each feeding on and contributing to the other. And it constituted what was clearly the one administrative service that was based on the most thorough appreciation of the idea that Jefferson thoroughly understood: that only by a command of the sciences could government and politics and administration reach their complete fulfillment in freedom.

When late in the Second World War I was borrowed out of uniformed service and put to work in the Budget Bureau by Harold Smith on a very interesting assignment, the Agriculture Department is the first one that I turned to. My assignment was simply this: "Look here," said Harold Smith, "these scientists have done some remarkable things that you know about, including radar and proximity fuses and various other things. They have done one or two other things that I can't tell you about for two or three months" -- this happened to be the atomic bomb, but he didn't tell me at the moment -- "and the world is going to be different at the end of this War, and the sciences have got to be brought more thoroughly into the administrative and political system of this union. I want you to help me make a study of what should be the political, the administrative, the constitutional system on which that relationship should be based."

I of course with no hesitation whatever trotted over to the Agriculture Department.

That was for quite obvious reasons. As several speakers have pointed out, agriculture had about 47 percent of the Federal research budget, and it was the only one which really had a feel for science as an intrinsic part of its political and administrative system.

You might, if you like, say that Henry Wallace was not particularly discriminating in his political judgments, but there was no question that he was a great administrator who understood science in its relation to administration, and the Agriculture Department seemed to me the very flower of its type among administrative services throughout the world.

The first man I went to was Budget Director Jump. I said I wanted to learn all about the system. I knew a little bit about it, as any student of government did. The thing that Jump said that surprised me, coming from a Budget officer, was something that really struck at the very heart of the conventional administrative and organization thought of the time. That was a set of ideas which called for a complete system of managerial and administrative responsibility with clear lines

[1] Presented as an informal after-dinner talk and not an article prepared for publication.

of coordination and absolute forbidding of any overlapping or duplication of functions.

Jump said, "You don't need to worry about this with scientists. Really in this field they have more of a system for letting each other know what they are doing; they have more of an incentive for avoiding overlapping and duplication because if they should discover something somebody else has discovered they get no credit for it. This is a system you have to run on different principles."

This shook up initially my original prejudice about this business.

There were other reasons why the Department of Agriculture appealed to me at this time. As Vannevar Bush and his colleagues turned toward the planning of post-war science, having through the Office of Scientific Research and Development brought about very earth-shaking results in technology and weapons development, their main fear was the fear that had stopped Federal support of science during the 1930's, the fear that there was no way in which the Federal Government could support the sciences without destroying the freedom of science.

The record of the Agriculture Department was absolutely clear on this. We called it then cooperative federalism and thought we had invented a fancy new term. It is creative federalism today. It is the same thing: the notion that it is not necessary in a great national system to destroy freedom and variety, simply because that system has to be financed from a central source.

This was something that, it seemed to me, the nuclear physicists from the metropolitan institutions of the country did not then understand. They did not have the benefit of something approaching a century of agricultural research to contradict their presuppositions and their prejudices.

I was even more interested in some rather technical details. After all, it had not proved necessary in the agricultural program simply to dish out money without any strings whatever in order to maintain freedom within agricultural research.

A great deal has been said today about the Hatch Act. Nobody has mentioned the Adams Act. But in 1906 it was quite clear that the early allowances of funds with no strings had brought about the use of an awful lot of Federal money for rather routine administrative purposes. And the Adams Act said its funds had to go for original research, and so introduced another element of genuine responsibility into the system.

It was only the year in which I went to work for the Federal Government, as recently as 1935, that the Bankhead-Jones Act introduced for the first time the notion that not all States had to be treated alike and maybe the Federal Government had the right to say to a State, "Put up your share or we won't put up ours."

These two statutes seemed to me very important clues as to what might be done without destroying the freedom of research as we moved into the new era of Federal support of the sciences.

But all this of course was merely my professional interest, and one's professional interest is only at the surface of the way one really thinks and believes about political questions.

In a deeper way, when I put that term "agrarian tradition" on to the title of this talk, I did not mean it in a derogatory sense. Partly because I was something of an amateur historian as a student -- and the Jeffersonian tradition seemed to me to embody the heart of the American notion of politics -- maybe also simply because I came from the Appalachian backwoods, I really did not think of the agrarian notion about politics as something to sneer at.

It is easy to make fun of oversimplified Jeffersonianism, the superior moral virtue of the farmer, the iniquity of the city dweller. This, of course, in the age of urban America is likely to look a little bit silly. And yet I was positively delighted to hear the Secretary of Agriculture today talk with some regret about the way in which people were "bottling themselves up in big cities." I think that is an exact quote. If he weren't willing to say it, I would be willing to say it for him. Because this represents in some sense a kind of popular agrarianism that has lasted throughout our history -- a combination of a regard for the quality of living, as against the notion of merely making a living or making money; a tradition that there should be a genuinely popular democracy, with no concession to the Hamiltonian notion that corruption by the wealthy was necessary in order to lubricate the institutions of a republic.

These notions are so conservative that they became radical. And in an industrial and technological society, which in the 1930's still seemed to be dominated by irresponsible corporations, the notion still seemed to me worth keeping in our memory that we might restore the dream of a political system in which the agrarian ideal would have some role.

If that is radicalism, it is a type of radicalism that makes Marx irrelevant, and leads us off in a quite different channel of political development.

I will admit, while indulging myself after dinner in a bit of reminiscing, that there was another layer in my education. I had a brief period of academic exposure as a student at Vanderbilt University in the early 1930's to the Nashville agrarians, the group who wrote that famous symposium, "I'll Take My Stand." And this was a crowd, some of whom were artists, some of whom were students of English literature, and a few philosophers, profoundly dissatisfied with industrial America and its view of the future of America. They were quite divided and uncertain as to their ultimate philosophical commitments. All agreed however that the farmer had a bad time and that they wished it were better.

I don't really take very seriously, and never did, some of their basic philosophy. The main point was better expressed by one member, a quite irreverent and unscholarly type, who made his pitch on the ground that the farmer's economic role in this country was a little bit like that of the runt in a sow's litter. This, of course, wouldn't apply to the new kinds of hogs that the Agriculture Department has invented. But in the old days of the razorbacks there was always a runt in the litter. And this, in the symbolism of Andrew Lytle, was what the farmer's lot was like in American society.

He entitled his essay -- of course somewhat inelegantly -- "The Hind Tit." The farmer, he said, was like the runt who was on the "hind tit" of the old razorback sow. And the view that the farmer had to think of his role in society somewhat separately, one where for the moment he was in an inferior economic position but he had to scramble to get into a somewhat better one, this was a part of a tradition that still I think finds expression in our political life.

Thomas Jefferson had been a good bit more sophisticated. And he had really looked forward to the possibility of agricultural sciences as an academic business. I ran across one of his letters some months ago while reading through the collected volume of his papers. In this he says to a correspondent that his ambition in founding the University of Virginia is to see that agricultural science is restored to its rightful position. Agricultural science, he said, should be the crown of all the sciences. And he goes on to propose, and I am quoting directly:

"The same artificial means that have been used to produce a competition in learning may be equally successful in restoring agriculture to its primary dignity in the eyes of men. In every college and university a professorship of agriculture, and the class of its students, might be honored as the first."

This was Jefferson's version, perhaps, of the special fellowship or the project grant.

I have a great deal of sympathy for the agrarian tradition and I should not like to be thought of as against it. If I have any prejudice it would be that I would like to know how to make the Jeffersonian vision a reality in a modern industrial civilization. And if, as I go on now to talk directly about the Department of Agriculture, I make any comments that may seem to suggest that I think there are defects in the Department of Agriculture, I would much rather have you interpret them according to the formula Dr. Mehren used today: I am not talking about defects, but in his words, "I am merely pointing to substantial opportunities to heighten our own productivity."

Why should we worry anyhow about all this? After all, after nearly three quarters of a century in which the productivity per acre on the part of the best farmers did not really go up substantially, beginning in 1940, it doubled within less than 20 years in the principal grain crops of this country, or very nearly, or so my agricultural friends tell me.

This is a feat that has brought the admiration of the entire world.

When on behalf of the Ford Foundation I went to Poland 7 or 8 years ago I called on the head of the Ministry of Education. He promptly harangued me on the superiority of the Communist system, and how China was going to surpass India, and Russia was going to surpass the United States, and so on and so on. And being a foreigner and a guest I didn't undertake to debate him, but I looked a bit incredulous and he stopped and said, "In everything but agriculture. I wish we knew how you did that."

When it comes to the overseas agricultural development business, as I promptly learned in a brief tour in the Ford Foundation, the land-grant college is indeed, as speaker after speaker today has noticed, the model for the world. And it was M. L. Wilson and Douglas Ensminger and Carl Taylor and Howard Tolley, and a number of other of your old colleagues, who formed the backbone of the early years of the Ford Foundation overseas development policy.

We did all this in our national agricultural programs and kept the family farm at the same time. There is no wonder that the world abroad stands in some amazement at this accomplishment. And yet as I listen to what is said day by day, week by week, in the world of agriculture, I hear evidence of discontent. If you take as samples the reports of the Committee on Agricultural Sciences of a couple of years ago, the President's Science Advisory Committee Panel in 1962, whose opinions were pretty much echoed by the Committee on Agricultural Sciences, or indeed the articles in a whole series of bulletins and journals of the Department of Agriculture itself, you will see a number of complaints emerge in chorus. The first one is always this: We ought to do more basic science. This complaint is perhaps to be discounted, for nobody in the world knows what basic science is. At any rate, I don't think I should try to define that term. All I can say is, whenever a group of scientists get together and attempt to define it, I know I can go away for 3 hours and come back and they will still be at the task. And when I was in the Defense Department in the Research and Development Board, a new political top command came in and said there should be more basic research. So I looked through the budget lists the following spring and here were projects that the previous year had been classified as applied research and they had all of a sudden become basic research. And then Charles E. Wilson came in saying, "Basic research is when you don't know what you are doing," and the next year all of those projects switched back and became applied research.

So I became, Dr. Mehren, as skeptical as you are about the ability to reduce this field

to any precise set of quantitative formulas. I wouldn't quite echo "Engine Charlie" Wilson. I would only say I define basic research as when I can't understand what it is they are talking about.

On whatever basis you define it, there seems to be less of it going on in the Agriculture Department, and under its auspices, than in some other places. At any rate, agricultural leaders themselves think there should be an awful lot more of it.

Second, they seem to think that the Agriculture Department may be suffering by confining itself so nearly exclusively to the support of research in the land-grant universities in particular, and public institutions in general. And they seem to think, too, that perhaps better results could be gotten if it were possible to concentrate a bit more on work of the highest quality and to put a little bit less in a great many detailed research programs in a great many small institutions.

I would offset that complaint by the comments of President Ellis and Secretary Freeman today: just try to close down some of the small ones and see what happens to you.

And fourth, there is the chorus which says we can no longer look at the farm problems and agricultural productivity alone; we must range over the whole gamut of the national resources problem. We must look at the broader problems of science. We must look for initiative to go into new problems and for procedures that will let us push ahead into new problems.

I noticed today that Ted Byerly was worrying about $125,000 for new research projects, which would be too small an item in some Department's budgets even to be noticed by a budget cutter. And I remarked in the discussion today that the experiment stations now seem to be getting about $30 million from other agencies than the Department of Agriculture. Four years ago I think it was about $17 million, while the Department of Agriculture was putting only 3 or 4 million dollars of its funds into other universities than the land-grant institutions.

I noticed today that in much of the discussion there was an emphasis on the fact that, given the conditions of modern society, you could no longer draw a neat line between the concerns of the rural world and the urban world. That dichotomy, said President Ellis, is past. And Dr. Mehren made the point very forcefully that the Department of Agriculture now has to look on city folks as well as the farmers as its clientele.

It used to be said by Mr. Dooley that the Supreme Court followed the election returns, and I hope that the Department of Agriculture can be at least as progressive as the Supreme Court.

Of course, if you look at the land-grant colleges themselves, or what used to be called the land-grant colleges, the remarkable thing is that they are now all or nearly all State universities. And this change may not be as significant as what they are calling the work they are doing. Chancellor Aldrich talked about this a bit today. He mentioned that at Michigan State and Rutgers and Texas and one or two more, they now call their agricultural schools colleges of agriculture and natural resources, or colleges of agricultural and biological sciences, or whatever. He might have added that one experiment station is now called a research and development center in a State where the governor is interested in using it to help bring new industry into the State.

At any rate it is quite clear that things have changed in the university segment of this separate world of agriculture, which a generation ago was a tightly knit unit where the universities fed the Civil Service and the Civil Service fed the universities, and they all worked together to defend the farmers against the great brawling world of industry which represented in some sense a different segment of American society. But now the lines between agriculture and industry, or between urban and rural interests, are getting very much harder to draw in the land-grant universities.

I don't know whether these several types of complaint about our current policy are valid or not. If you ask somebody to talk about agriculture and its relation to science, it might have been better to ask somebody who knew something about at least one of the two. But since I don't, I can only serve as kind of a reporter, an outside reviewer of what insiders seem to be saying. This is always a dangerous posture to adopt.

And yet even though there seems to be some consensus in these directions I have mentioned, I think I detect a certain feeling of fatalism, a certain type of helplessness about it. We would like to move in certain directions, but you, of course, know the political difficulties.

I do not propose to try to answer the question that is bound to come up after I sit down: Just what would you do about it if you were Secretary of Agriculture? I am sure I don't know. Instead of giving you any such prescription, what I would like to try to do tonight is to carry the diagnosis a step further, because I think there is a certain amount of politeness that still inhibits the communication between the National Academy of Sciences types, if I may be crude in my terminology, and the Department of Agriculture as an organization.

And here I speak not as a dean of Public Administration, in which capacity I have learned nothing whatever about this problem, but as an old Deputy Chairman of the Research and Development Board and one who has had other connections with some of the Federal scientific agencies. And in those capacities I have taken my beatings and perhaps learned a little about the problem.

First, I think that one has to look at the trends in basic science itself as a causative factor here. Something like a century ago you could tell with some clarity what

agricultural science was. It was not the same as industrial chemistry. It was not the same as physics. It was not the same as geology or whatever. Jefferson could quite plausibly say, "agricultural science," and anybody knew what he meant. As we listened today to Chancellor Aldrich and to Dr. Handler, it was quite clear that nobody knows any more what this means. And if they do not know what it means, it is because the basic sciences, as they have become more abstract and more general in their interests, have so blurred the dividing lines between the disciplines that it is no longer useful to try to distinguish them very neatly from each other.

It is still quite useful to distinguish them from each other at the applied and the developmental level. There is no quarrel with this and no problem about it. But in that segment of basic science where the most advanced work is being done, where the frontiers are being pushed ahead most rapidly, agriculture is not immune to the principles that have governed the progress of those sciences with which the Defense Department or the Space Agency or the Atomic Energy Agency or the National Institutes of Health are concerned.

The sciences, as they have gotten rid of the notion of teleology or purpose, and became more mathematical, more abstract, more general, have come to interlock and interchange much more effectively, and I take it that that is what all this talk today about interdisciplinary activity was really about. I take it too that this means, whatever one thinks about the great majority of work of an applied nature to be supported, that the work on the advanced frontier, the cutting edge of the business, the highest quality work, is work which cuts across these boundaries and can be pushed effectively only by scientists of the very highest quality.

I hope nobody misunderstands me and thinks that I believe that work of the highest quality is peculiar to any particular type of institution. On the contrary, institutions of each type vary very greatly in quality. One of Ted Byerly's staff was up at our school several years ago. It may surprise some of you to know that the Graduate School of Public Administration at Harvard has had anything to do with agriculture. Ever since John Black's day we retain a fondness for this field. Indeed I was told when I got there, to my surprise, that we had more of our alumni serving as directors of State extension in agriculture than any single land-grant college. I can't vouch for it but I think it is possible. At any rate we have had, to our great pleasure, a number of Agriculture Department people there. One of them made a very interesting study 3 or 4 years ago about the State experiment stations and the variation in their quality, and they vary in quality tremendously by whatever crude criteria you might choose to measure them.

You can take as criteria the quantity of research publications per research worker, or the number of graduate students associated with each research worker, or the percentage of basic research that is done at them -- all of these things have a very high correlation and all of them also correlate very highly with the proportion of staff members who are selected as consultants or advisers by other experiment stations when they want advice from panels of consultants of the division of -- what is it called now, the old Office of Experiment Stations, Ted? I always forget the new terminology.

MR. BYERLY: Just keep on forgetting.

MR. PRICE: At any rate, the variations of quality here are tremendous, and the experiment stations of highest quality are obviously those which are associated with those universities that are not necessarily in the States of the highest farm income, but are in the States which are prepared to support higher education of the best general quality.

If I emphasize advanced research, it does not mean that I am not interested in the quality of teaching, or that I disapprove of the kind of general institutional grants which President Ellis was talking in favor of today or that Russ Thackrey's association has come out in favor of. I am on the record in favor of both of them and in favor of means of having, to the maximum possible extent, higher quality education distributed throughout every region of the country.

But it is a little bit like the old story about the Frenchman who, when reproached by his mistress who said, "You think love is only one thing," he replied, "No, I simply think it is a hundred things and not just 99." I am now talking about only one thing. I am taking the 99 for granted. And I am asking how in the world of agriculture can we make sure that the Department of Agriculture can command its proper share of the top research and intellectual abilities of the country?

I would like to say a few words as a former staff member of the Research and Development Board of the Defense Department -- one who part-time and full-time watched that program develop for something more than 10 years.

The first thing that I remarked about it as a bureaucrat -- this was quite against my earlier preconceptions about hierarchy, lines of authority, and responsibility and so on -- is that if you go to the big industrial corporations and see how they do it, whenever they want to organize basic research they set it apart from their applied research and their development. You don't find the Bell System putting their basic research people into the same organization with the product improvement branches in their subsidiaries.

And the military, of course, learned from this. If you are going to protect basic research, you have to distinguish between that and your applied research.

The second thing I learned had to do with something that is called in military language, as you all know, "the requirements issue." The old military system had it that research

was done only pursuant to the demands and prescriptions outlined by professional operating soldiers, who might say we have a need for a certain type of weapon; develop it for us according to these specifications.

What happened during the Second World War was that scientists ignored or evaded this kind of control. The Office of Scientific Research and Development was set up to make it possible to ignore or evade this kind of control, as a result of which, scientists produced weapons which no professional military officer could have dreamed of because they didn't know they were even possible.

I was bothered today, I must admit, when we were discussing the question how much agricultural research was assigned outside the land-grant universities, and we were told that the criterion for allocating such research was only when we can see -- or at least primarily when we can see -- that work of a particular nature can be done best by a particular institution. It seems to me that this is the exact reverse of a policy that might be followed if work of the highest quality is wanted in the institutions where the scientists of the highest ability can be found; it ought to be put there especially if you don't know what you want to do.

Here is where, without differing in the slightest from Dr. Mehren, I would say that systems analysis and systems approach, and indeed the whole approach of logical positivism, really doesn't govern research policy. I don't know about the National Academy of Sciences. Some day, if I ever get to be a close enough friend of the President or the Chairman of the committee on science and public policy, I would ask him to let me come in and study that Academy to see whether they make up their budget, and they make up their program, according to a system which follows the full intellectual rigor that scientists of a logical positivist frame of mind would like to see applied. I am reasonably certain that the science faculties of Harvard University, in planning their program, operate much more on the same basis as bargaining, guess work, hunch, and hit and miss negotiations that characterizes the Budget Bureau in Washington, and I am inclined to think that fundamentally the rigorous approach of systems analysis can be followed only when you can first define in advance the precise parameters of the objective which you want to accomplish. And whenever you are dealing with future unknowns, it won't work.

This seems to me to be contrary to the usual justification for what is conventionally called the project system.

The project system has had some unfortunate byproducts in a great many institutions. I agree with President Ellis about those unfortunate byproducts. I agree with other critics of the system. It has led a good many people to be entrepreneurs whose approach would make a bucket shop operator look fairly modest in his activity. It has led a lot of people to ignore teaching or try to escape it, and all the rest. And yet it doesn't seem to me that, at the upper levels of the system, this is the main incentive or motive.

I have sat in a good many committee meetings where leading scientists talk about the project system and alternative systems of support. And I hate to say this as a dean, and I know that it may offend President Ellis as a university president, but it seems to me that the scientists like the project system less because it lets them evade teaching responsibilities than because it lets them evade the supervision of their deans and their presidents. That is to say, putting it in terms which they would prefer, it gives them freedom. It lets them do precisely what they want to do and it prevents any necessity of fitting into a university program.

This is why it seems to me that the main merit of projects -- and I will not debate the balance between their merits and demerits -- the main merit of the project system is not that it is particularly good at buying particular research, any particular objectives, but that it is good in that it lets panels of other scientists ignore what the dean thinks about it and ignore what the granting agency thinks about it, and it gives the scientists' club the right to give money to the colleagues that they respect the most to use on terms that they think most suitable.

I cannot tell you how incredulous I was when I first discovered that the main thing that held back a number of agencies of the Federal Government from paying full costs, full indirect costs, or, if you like, full overhead, to universities was not congressional prejudices or bureaucratic prejudices. It was because the university professors themselves looked on any payments that went to their university administrations as a net subtraction from the money that they might have for research. And if this seems impossible for you to believe, I will cite the example of the astronomy panel of the Office of Naval Research, which looked at the total pool of money available for astronomy and said, in effect, "We won't pay the ONR going rate for overhead." Harvard University said, "We won't take it without the standard overhead." As a result, for a number of years, Harvard University has not been getting astronomical research contracts from the ONR.

How did this business then evolve shortly after the War? The project grant was the obvious successor of the wartime contract. Whether the grant or the contract was used as the mechanism seemed of symbolic importance to some people, but the net practical effect was mainly that in the contract you could pay full overhead and in the grant you couldn't. The degree of freedom was practically the same.

As I saw this develop after the War it looked to me like this was about the story. The Air Force was split off from the Army, taking with it nothing but its fliers. The Army therefore

kept all of the research and development structure of the old Army, and this was its great loss, because being saddled with the armories it was not free to develop other means of research support.

The Air Force was free and it decided -- I don't know whether it looked at the field of agriculture as a precedent or not, but it decided that in-house research was not the way to do the job, the Office of Service and Research Development had had the right idea: it would buy its research wholesale, and it set into the business of research grants and contracts in a big way. And the Navy, of course, was not to be outdone, and through the Office of Naval Research it even outdid the Air Force in providing money to scientists on their own terms. If it had not been for this competition among the military services there would have been much less of a seller's market in brains, so to speak, in the years that followed the War. But there was this seller's market. It had all of the bad results of free competition and over-pricing, but it was a seller's market in brains. And the poor Army was behind, because just as it had been saddled a couple of generations earlier with over-reliance on the State militias and over-reliance and over-commitment of funds to the Indian forts and the posts in areas that no longer needed to be defended against the Apaches or whatever, now it was stuck with a lot of armories that were much less flexible, much less closely tied to intellectual centers of rapid advancement, and much harder to administer than the new contract system.

I think it is important to be very candid about what all of this amounted to. What it amounted to was that at the end of the War, looking at the results of the Manhattan Project and the OSRD, each of the military services first, and then the Atomic Energy Commission, and a good bit later the Space Agency, said in effect, "We are going to buy a good share of the scientific talent of the country on whatever terms we need to pay, and we are going to have them on our side. We are going to have them on our side not merely to do research, because we really don't know what they are going to work on specifically, but because if we have their interest and attention, their graduate students will come along and be devoted to problems which are of interest to us. And this will have profound effects on the future of our business, both with respect to the development of a whole body of basic research on which we can draw and also because we can draw on the young scientists for our civilian bureaucracy."

This was in the 1950's a crude new counterpart of the Agriculture Department in the 1930's. But it was a new form of federalism. Instead of a single set of public educational institutions being committed to a particular type of Civil Service and a particular Department, it was free competition among the Executive Departments for public institutions and private institutions alike.

It perhaps was a realistic recognition of the fact that careers in modern society could no longer be changed year by year according to the momentary activity of the particular individual; that more depth of knowledge was required for a professional career. We could not have in the sciences any more than the military services minutemen jumping from the farms on short notice to defend the country. We had to lay the groundwork for long term career development, for the complex of research and bureaucracy, and indeed for the informal political organization and alliances which would sustain any major program.

What this comes to, I think, is that just as the basic sciences have broken down the boundaries between them, so have the various aspects of technology. As a result of the breakdown in the boundaries among the fields of technology, and as we heard ad infinitum today, the boundaries between the Executive Departments are no longer neatly definable. This strikes at the heart of the faith on which I, as a public administrator, was brought up: you had to have neatly segmented departments, with clear lines of authority and no overlapping, in order to be able to have responsible government.

How can we do that today? Let me just recount -- I took notes -- the subjects that were mentioned today, and you tell me whether it is clear whether any one is a part of agriculture or a part of something else: outdoor recreation, environmental health, nutrition, the synthesis of proteins, preservation of foods by irradiation, water resources, weather modification, and rain making.

A fairly formidable list of technologies and sciences! And I think that probably, if you ask the average independent observer, he would say that in none of them was agriculture clearly in the lead among the Federal departments with respect to the support of those branches of science which were going to be out on the frontier in the future.

This may not be a fair judgment, and I would be happy to have you tell me that it is not. But to the extent that it is fair, I think we have to talk not in terms of whether the agricultural research program has been a success, about which there is no question whatsoever, but in terms of the question whether the form of federalism to which the Agriculture Department is still committed enables it to compete adequately with other Executive Departments in looking not to its regular applied fields of research -- on that there is no question -- but toward those branches of research which are going to be the new frontiers of science and development in the future.

And if I were to try to sum this up I would say that it seems to me that the pattern commits the Department of Agriculture to a system which is in scientific terms rather unduly conservative.

One might say that it is something like a Commodity Credit Corporation system for the

administration of the Department of Agriculture, meaning that the governance of the scientific program is dominated by the colleges, the commodity groups, and the congressional committees. And this is fine for the great bulk of the work, because I have absolutely no quarrel with the notion that a Congressional committee or a commodity group ought to be able to say we want our particular crop worked on by your boys at your college, and we want a good job done.

For 90 percent of the business, this is first rate.

But it comes closer than I like to committing all of the program to what one would have called in the Defense Department the requirements approach, that is, to work in fields which have been predetermined for the scientists by others. And if I were to have a philosophical difference with this approach it would be on the following ground: it seems to me that science in the modern world can no longer be merely a tool used by the political leader and the administrator to help him carry out policies and attain objectives that he has already defined. The policy-making process is far more subtle and complex than that.

The administrator and the politician cannot have their full range of options, their full range of freedom of choice, unless the most advanced scientists can, by exploring things that have previously been unknown and unimagined, tell the administrator and the politician what new options and choices are going to be open to them that they had never imagined.

And so I would really like to see the Agriculture Department have more strings to its bow, more variety, more of an opportunity to go to any research institution and any university or college in the country, and to add to its initiative and its scope and its independence, by giving its best scientists a chance to work toward the Department's broad objectives. It could do so either by institutional grants, or if you prefer, by project grants. As to that choice, I couldn't care less.

If anyone proposes such a system of discretionary grants, the conventional reaction will surely be that this step would represent a diminution in Congressional control. I don't think such delegation represents a diminution in Congressional any more than in Executive control. It is only if both the Congress and the Executive Branch are willing to grant a measure of freedom and initiative, and if you like, free competition, to scientific institutions, that those institutions can do the kind of job for political leaders which will justify their support at the highest levels.

I said a moment ago that this violated my old administrative and bureaucratic principles and prejudices. The old conventional proverb of administration was that scientists should be on tap, but not on top. This is the principle on which the British Civil Service, with its great merits, has always operated. The scientist cannot rise to top administrative positions. His work is supposed to fit into a "requirements" pattern.

This has never been true in the United States, and the Department of Agriculture is the best example of that.

There is another way in which it violates my early Jeffersonian prejudices, and that is that I think that this forces us to admit that science can really play its full role in our modern society only if it is looked on as something like an "establishment," to use a term that British authors have more recently made a dirty word. Only, that is to say, if it has some long-range independence of political control.

Mr. Jefferson disliked this idea on principle. To him an "establishment" meant either the lawyers--whom he disliked and distrusted--or the priesthood which he disliked even more. In theory, he disapproved of establishments.

But in practice, if you forget about his theory, it isn't quite so clear what he was for and what he was against. Because, after all, throughout the years when he was President of the United States, he was president of what was then the principal scientific society in the United States--the contemporary version of the National Academy of Sciences. As president of the American Philosophical Society, for something more than 20 years, Mr. Jefferson was at the peak of our scientific as well as our political institutions. And in that capacity he was certainly never prepared to subordinate science completely--and on a line item budget basis--to politics. Nor was he, when he founded the University of Virginia.

If I were to try to reconstruct a philosophy of agrarianism for a modern age, I would appeal to Jefferson in action against Jefferson on paper. I would think that Jefferson and his agrarian tradition ought to be able to rise to the opportunity of using the highest type of science available in our society without regard to the institutional dogmas of the late 18th century.

In short, if I were forced to profess a specific traditional political philosophy--which would be an uncomfortable position at best--I would be more tempted to start with the agrarian tradition than any other one I could think of. And it seems to me to have three or four essentials, and these essentials are different from the mere accidental institutional forms that it took either in Jefferson's day, or in the days when the Hatch Act was first enacted.

These essentials, it seems to me, are these: First, the ability of an administrative system to protect freedom by decentralizing within its own establishment, so that it is not necessary, when you decide that a policy problem is of national importance and requires national support, that it be governed by a highly centralized bureaucracy. This is the quality that has enabled us in this country to have our radicalism move in the opposite direction from European radicalism which from the French

Revolution supported administrative systems that became more and more hierarchical and more and more authoritarian, while we became more and more populist and more and more decentralized. If I illustrate the decentralization of power by mentioning crop referenda, which could not have been imagined in the early days of the Republic, or the status and influence of the Office of Experiment Stations within the Agriculture Department hierarchy, you will know what I mean.

The second point would be the predominance of the genuinely popular interest in our country against any form of privilege.

The third that I would mention would be a concern for the quality of our civilization against the accumulation of mere wealth, or the enlargement of mere technical power.

And the fourth would be a faith that science, for all of the awesome power that it has turned loose, still has the potentiality for being a force for liberation of the human spirit, rather than for the oppression of mankind.

These, it seems to me, have not been made obsolete by the new science, even though the new science may be forcing us to readjust many of our political institutions. And I hope that the Department of Agriculture will long flourish and pursue the mission of supporting them.

DR. MEHREN: Thank you, Dean.

This has been a day in which many people have spoken candidly and non-crudely; in which many people have been provocative. You have been both candid and provocative.

It is very late, but everybody else who has spoken quite so freely as Dean Price has spoken today has been required to answer up for it. If you would indulge it, I think we should give him 10 minutes, at least--what the rest of us who ventured less provocative opinions, perhaps less candidly than Dean Price expressed them, and perhaps more crudely than he did -- took as our rap.

There are things that Dean Price has said that puzzle me. I listened to one small point of the British Civil Service, and the role of the scientist in it. Snow, who spent some time with your people and some time with my people, wrote a pleasant pamphlet on the battle between two scientists--one who worked with Churchill and one who didn't. Then he wrote an appendix long after he had written that. You remember the last two or three sentences in which in this British Civil Service, in which you say the scientist has done that which he should do, and no more, and no less, Mr. Churchill once said "Go to Mr. H, and get a definitive opinion." And Snow said that no matter what we have done before, and no matter what we do now, this must never happen again. That was a provocative statement, and is open to debate.

Your statement on logical positivism hurts me. I see no intellectual, ideological, or positive basis for being against logical positivism and mission-oriented research. But since we have been candid and provocative and not crude, I will let it pass.

I am not quite sure whether Dean Price wants us to go back to what Jeffersonianism may have been, or what perhaps it should have been. And I am not sure I know exactly how you tailor a research program to do this, if that is what you want.

I think in common decency, and out of respect for the dignity of man, and out of a common respect for the whipping that some of the others of us here who ventured opinions today got wrapped for, I think again that Dean Price ought to have at least 2 or 3 minutes of being questioned.

DR. BYERLY: Mr. Chairman, may I express my admiration for the artistry of the man from a small village in Massachusetts who knows full well that a blunt needle of large bore is more painful to the recipient than the sharp one suddenly thrust.

DR. PRICE: How can I field a question like that?

DR. BYERLY: The pair of you up there, pragmatists, arguing over whether or not you should establish principles from which you can recognize your deviations. My question, sir, is: What is a private university?

DR. PRICE: This is a question that I am just delighted with. Harvard University, of course, was founded and supported by the Massachusetts Bay Colony as a part of the established church, so Harvard cannot traditionally be called a private university. It became one in the 19th Century.

I went up there 7 or 8 years ago, and I had been there 2 or 3 years, and I got more and more bothered by some things I saw. I ventured one day at a meeting of the Council of Deans to ask the following question and I thought I would be fired. But I wasn't.

I said, "Harvard is now getting to the position where the land-grant colleges were 60 years ago, and we don't understand it very well. Hadn't we better do something about it?" The result of that question was a study by Harvard of its relations with the Federal Government and the Carnegie Foundation's supporting of a number of other universities making similar studies.

Harvard gets 30 percent of its operating revenue from the Federal Government. That is probably about what the University of California gets. Yale and Princeton are ahead of Harvard on this percentage and, of course, Johns Hopkins--if I may be forgiven other references--and the University of Chicago are still further ahead. I don't know what a private university is and what a public university is. Why should this be new to anybody in the land-grant business? Cornell, what is it?

I think the fact is that a university is a university and the State universities, so-called, have more and more been taking on qualities of independence with private support and behaving like private universities, while the private universities, so-called, have been becoming more and more instruments of public responsibility--and in some cases deliberately and self-consciously so--and I think this is a fine thing.

It seems to me that this is ample warrant for the distinction that is made in our national policy between the levels of higher education, on the one hand, and on the other hand elementary and secondary education, in which public is public and private is private. That can be debated too, now. The higher education level, I think, cannot.

DR. MEHREN: Who else has any difficult questions to ask? And while you are thinking--

DR. PRICE: About Snow, you were asking a question I didn't answer.

DR. MEHREN: Why don't you put Snow where the people aren't? That's the question I was going to ask. You don't do that in Harvard; in Berkeley we always do.

DR. PRICE: No. As for Lord Snow -- or to use his old title, Sir Charles -- anyhow, I thought that he was writing a beautiful story, but one which really had relevance primarily to the British setting. He wrote about Lindemann and his almost hypnotical personal control over Churchill. But we don't have that problem. Even in my day in the Defense Department, there were 15 or 20 scientists licensed to advise the President, and an equal number for each of the military secretaries.

The problem for us is: Can you get anything decided without having a thousand people involved arguing about it? I could never see the relevance of that particular piece of Snow's fable to our business in the United States. I fully agree with him in principle, that if there were ever a strong, central executive who was advised by only a single scientist, I think it would be a disaster.

DR. MEHREN: And I would agree that in view of what we have done in the past and what we do now, this should never happen again.

I think somebody should be mean enough to ask the Dean whether he really thinks that the Jeffersonian tradition, as he sees it, and for whatever it may have been and for whatever relevance or quality it may have now, is really what the Dean wants us to do presently. If so, what do we do with our research program to make it so. After that, we will let you go to bed. Unless you want to start an argument.

DR. PRICE: The Jeffersonian tradition is really a mood and general outlook and not a pattern for action, obviously. Anybody who would, a century and a half after a political leader -- no matter how much he might feel sentimentally involved with him -- say that we can go back and scrutinize the record of the master's words and derive a program of action, would, of course, be just silly.

It only seems to me that Jefferson deserves a particular niche in our thought, because he was, for all of whatever shortcomings he might have had as a philosopher, he was profoundly optimistic in an era when that represented the real change in the political tradition of the world. And this is something that I think I would like to see cherished as a mood and an attitude, even though intellectually I cannot agree with it completely as a philosophy any more than I can try to derive operating maxims from it.

DR. MEHREN: We always hit the hard troubles; if you quantify your variables you narrow them. That may be a West Coast viewpoint. I say again it has been for me, at least, a beautiful day.

I think the best thing that happened in the day was the sotto voce comment from Dr. Hawkins at one stage in a hot argument this afternoon, in which somebody said: Why can't people get together and talk? His statement was: "If they want to get together and talk, the way to do it is to get together and talk." I suppose that is what we have been doing. And I am in favor of it. I hope we have a lot more of it.

DR. HAWKINS: Mr. Chairman, you missed one word. I said "work". I didn't say "talk."

DR. MEHREN: That is the trouble with you Oklahomans. You don't get any fun out of talk. It is always work, work, work. In Italian it is lavoro, lavoro. You don't know what you are missing.

It has been a good day, and I am grateful. I am especially grateful to you, Dean Price. And while we probably shouldn't crucify you here, if you would like to sit down for about 6 hours and go over some of these points you just made, I would be happy to accommodate you.

Thank you all.

[Whereupon, at 9:52 p.m. the meeting was adjourned.]

February 25, 1966

DR. NORMAN: This morning's program is a rather full one, so we will get underway. I think I must say in advance to the speakers that if we have to terminate their particular part of the program, they will understand that this is done in order to not find ourselves short at the end of the morning.

The first topic for discussion is the long-range outlook for research in agriculture. This is a study that has been in progress for some 9 months. A required textbook has been distributed. It constitutes the background for the study, and, as you will see, is a joint effort on the part of the Department scientists and scientists from the Experiment Station Committee on Organization and Policy -- ESCOP -- land-grant specialists.

Two speakers then will handle this topic -- one from the Department, one from ESCOP. The first is Dr. Maclay, from the Department. He is a native of Nebraska, educated in Nebraska. He joined the U.S. Department of Agriculture utilization staff in 1940. He served in the Western Laboratory. He was first year's

director of the Northern Laboratory, and then he came into Washington as deputy administrator in 1959 and a year ago was named as director of the newly established Research Program Development and Evaluation Staff. His first assignment in this capacity was to put underway this study of the needs for agricultural research. Essentially this is what Don Price would describe as a requirement's approach, establishing what are the needs domestically for the long-range research program in agriculture. Dr. Maclay.

THE STUDY OF LONG-RANGE NEEDS IN RESEARCH IN AGRICULTURE

DR. MACLAY: Do you each have one of these books? I will stick pretty close to it. ["Progress on Long-Range Study of Agricultural Research"]

About a year ago the Secretary requested the then director of Science and Education of the Department, Dr. Nyle Brady, to undertake a long-range study of the Department's total agricultural program. About the time this was being discussed with, as I well recall, the Agriculture Research Planning Committee of the Department, the Senate Appropriations Committee issued a report in which they recommended that the Secretary undertake a study of the USDA and State Experiment Station Research.

Also included in that request was a suggestion that a classification system for agricultural research be developed so that they could better understand the greater variety of research, the magnitude of it underway in the Department and the States.

The basis of this was laid by the Secretary, President Ellis, the Chairman of the Executive Committee of the Association of State Universities and Land-Grant Colleges, in May. It was agreed to make it a joint study.

Six staff scientists of the Department represented the Department, and ESCOP appointed six individuals and those are listed on page 2.

From the experiment station group there is a representative of each of the four researches: Dr. George Browning representing the North Central Research, Dr. Fortmann the Eastern Research, Dr. Frevert, the Western Research, Dr. Wilson from the Southern Research, and two additional -- Dr. Doretta Hoffman representing the human nutrition and home economics field, J. C. Williamson, the marketing field.

So in the 12 people here we have two chemists, two engineers, two economists, two geneticists -- one plant, one animal -- a soils science man, plant pathologist, human nutritionist, and a market specialist.

We first decided we would have to deal with an overall plan for the study, and this plan was composed of three stages. Stage 1 to develop guidelines for the study. Stage 2, to assemble background materials and project research needs. Stage 3 would be to write the report.

Let's come to stage one. We felt we had to specify the objectives of the study and under attachment one we have outlined six general objectives for the study:

One, to define the goals and purposes, scope of agricultural research;

Two, project research needed in the next decade to help people adjust to their changing economic social environment;

Three, project research needed during the next decade to meet the Nation's future requirements for agricultural products and resources;

Four, to establish priorities for current and projected research;

Five, develop a research classification system; and

Six, to consider the respective roles, responsibilities, and areas of cooperative effort among the Department, State Experiment Stations, and other groups.

Secondly, we thought we would need to define the goals of agricultural research as we saw them. And under attachment two we have defined some 13 goals which we felt were important. These 13 readily fit into the Department's 8 missions or categories that have been recently established by the Department along with the Bureau of the Budget, which will be used in developing the overall Department programming, planning, and budgeting activity. And these 13 fit into those 8 very nicely.

For example, the Department has as one of its missions "adequate supply of farm and forest products." If you look at our goals as established there, Nos. three and four, No. four, to produce an adequate supply of farm and forest products and to decrease real production cost; No. three, to protect plants and animals from diseases, plant pests, and other hazards. Those two actually constitute the first mission of the Department.

Under attachment three, classification system, this is a three-dimension grid: A, the activity or why we are doing research; B, or commodity resource on what research is being done; and C, field of science and how it is being done.

These are broken down in each of these in general groups. And in the "A" activity these are now being grouped in the Department's eight missions so that there will be continuity between this classification system and that of the Department's missions.

All of these, the research of both the Department and the 53 agricultural experiment stations, which amount to 16,000 projects -- 13,000 in the States and between 3,000 and 3,500 in the Department -- are classified in each of these three activities. So if you will turn to the next page you can use this type of a grid. This has been computerized and we can print out activity versus resource.

On the next page, field of science against commodity resources. And at the lower part of the page you can get more detail. For example, under protection of plants, man, and animals, if you want to know what research is being done under citrus or corn, the A activity against the B activity, we can print that out.

On the next page, to take an example, such as cotton insects, with this classification we can print out how much is being done, not only in dollars expended but also by scientists' time. Here again we have used a uniform system for science man-years in which, for the States, we used a system of professors or higher, and in the Department GS-11 or higher. GS-11 is the normal grade at which we bring PhD's into the Department research structure.

We can tell where the research is being done in the field of science. Under the cotton insects, we can print out cotton insects, but you would have to go back to the specific cards to find out what research is being done on a specific insect such as boll weevil or pink bollworm.

But in the re-organization of our project system we will be able to print that type of information out on it. At that time if you want to know what research is being done on corn genetics we can print out, we will be able to print out research not only in the Department but in every State at every location -- the magnitude of it. We will have the title of the project, a 100-word plan of work, and annual progress statement.

In the next one, we wanted to develop means of inventorying research, manpower, and facilities. This is outlined under attachment four. We inventoried not only that from the States and the Department, working with Howard Sprague and the Agricultural Research Institute, but also we have attempted to get a sample of what is going on in industry. We have gone to the Scientific Information Exchange and sampled their projects to get an idea of what research relevant to agriculture is underway outside the Department's research stations. We have also inventoried research facilities in use or under construction.

Then we felt, to be fairly objective on how to evaluate research, we established criteria, and applied them in the consideration of individual problems. They were: the extent to which research meets experiment station, Department, and national goals; scope and size, considering area, people, and units affected; benefits of research in relation to costs; urgency of research; contribution to knowledge; feasibility of implementation and likelihood of successful completion in a reasonable period of time; likelihood that research costs will not be available elsewhere; and likelihood of extensive and immediate adoption of results.

In order to weight these we sent them out to 175 USDA experiment station administrators under 28 different pairs that are possible under the 8 criteria. We received 150 of these in return. Those were analyzed, and on page 2 of this attachment we were able to weight these with the urgency, the highest, which we indicated on a scale of 10, to a low of 5. Including a scoring from 1 to 5, we tried to determine the degree to which each of these research alternatives meet the research criteria. Dr. Browning will give more of that later.

And sixth, we wanted to provide a review procedure at each of the three stages so that we don't come up at the end of this study and find out certain organizations or certain committees that have responsibility in this field have not been keyed in on them. There are 5 committees given under section 6.

(1) The committee on agricultural science.

(2) The agricultural research planning committee, with six representatives of State universities and land-grant colleges, six representatives from the research agencies of the Department, one member nominated by the National Academy of Science, and one member nominated by the Office of Science and Technology. This is chaired by Dr. Mehren and the membership is given.

(3) A national research and advisory committee set up as a part of the Research and Marketing Act of 1946. In addition to this advisory committee under this group, we have 13 commodity and functional advisory committees, and they have had their inputs on this.

(4) The Experiment Station Committee on Organization and Policy, ESCOP.

(5) And lastly, the Secretary's program and budget review committee, chaired by the Under Secretary, and membership that consists of the Under Secretary, Director of Science and Education, Director of Agricultural Economics, et cetera.

These are the review groups. They reviewed the completion of the first stage. They are meeting in March to review the second stage.

Turning to the second stage, we have set up 9 groups -- one on inventory. Attachment 7 will give you the preliminary results of this inventory. This was the first printout, and we have found a few mistakes, particularly in the scientific man-years. But I thought it would be of interest to you to get a kind of bird's eye view of the Department's research.

Table 1 shows the totals in the field of conservation. About 12.4 percent of the Department's State research is in this field. Under the protection category, it is 29 percent; in the biological efficiency or production efficiency field, 35 percent. In the process and product development -- and that we call our utilization research -- it is about 11 percent; in the marketing research, 7 percent; food and nutrition, the home commission field, 2.3 percent, and in human resources, 1.8 percent.

The second committee had to assemble data on the future needs of people. We have had access to the Economic Research Service in this field. We also have a group working on the consideration of the respective roles and responsibilities in this cooperative effort. And then we turned our attention to the de-

velopment and evaluation of important research problems. I will ask my co-chairman in this study, Dr. Browning, to discuss that part of it.

DR. NORMAN: The two speakers agreed that we would go through the program and then invite questions and discussions.

The second speaker is Dr. Browning, of the Iowa station. He has been at Ames, I think, for 25 years. Since 1950 he has been associate director of the Iowa Agricultural Experiment Station. At present he is chairman of ESCOP -- Experiment Station Committee Organization and Policy. As part of the role of ESCOP he has participated actively in these studies. Dr. Browning.

DR. BROWNING: Thank you, Jed, and members of the Symposium.

The area that I want to cover this morning is to give you some notion of the Committee's effort to estimate the future needs, identify some of the important problems. Obviously, it is going to be quite summarized, because it isn't possible to cover all of these and to evaluate the current program that is underway, and to suggest some of the categories and to develop some of the guidelines that we might have in organization policy. It will be largely a matter of giving examples.

I might say a word about the classification. In September, the President, as most of you know, asked for an overall system of budgeting and classification for all departments of government. We have been at this a while. We were a little bothered as to how this might fit in. As time went along we were well pleased that the things that we had been doing in classification fit real well under the eight categories that have been referred to.

Actually, a good classification system obviously is one that we can put together under any combination. It is in small enough pieces so whenever the changes may come, which they will over time, we can regroup those or aggregate those into whatever system you want. We were pleased after this was done to go back and compare. As Mac said, from the 10 or 12 or various numbers that we had at times, these fit very nicely under the 8 goals that Secretary Freeman referred to yesterday.

One of the important things, of course, is that we now have for the first time on a uniform basis and a uniform classification an inventory of what this program is for the States and for the Department, an estimate of the industry, also those colleges and universities that are working on problems relevant to the area of agriculture.

Of course, also essential is the annual updating of this information each year, and working this into a reporting system which makes it possible to see not only what we are doing moneywise, but what the reports are as a basis for planning ahead and planning programs in the future.

We have drawn on several areas for the future needs. I am not going to take time to mention other than a few of these. Population certainly is one of the important ones that determines what these needs will be. What we decide as policy over the years in the international situation is another one that will need to be looked at continually. The numbers of farms are going down, as you know. And people living on farms are fewer than before. The inputs in fertilizer, seed, and this sort of thing are going up. These are some of the kinds of estimates that we need to make in order to gear a research program to answer the kind of urgent questions that are needed in the next 10 years. These will need to be also continually reviewed because these are projections. The crystal ball isn't that clear and they need to be changed as the programs go along, and as conditions and needs change.

Let me go to the eight general areas. I want to say that this is only a progress report under the eight areas and indicates some of the important issues or some of the questions that need to be answered as we see them at the present time. We are doing groupings and regroupings. We are at the stage right now where we are in the process of trying to boil this down, take a hard look at it. We have had the advantage of the panels that came in to review these. We had the advantage of a large number of people who are knowledgeable in this area. About 700 people had a chance to say what are the important problems in these areas where they were specialists. So it isn't just a matter of what the 12-man committee thought, but we have these plus the panels.

The purpose of agricultural research in this first area of adequate supply of farm and forest products is to be sure that we have an adequate supply at a decreasing real production cost. Currently, about 65 percent of the total research budget is in this area of efficiency of production -- protection from insects, diseases, and other areas like this. New technology from past agricultural research has made it possible for the American farmer to produce an abundance of food and fiber on which rests the strength and well-being of this nation. Strengthening the agricultural research effort in the future stands to produce even greater benefits than in the past. Families are eating better, as we all know, at lower cost. Our agricultural abundance also, as Secretary Freeman pointed out yesterday, is being used for AID and helping other people around the world.

Actually, when we look into this, the field, horticulture, and forest crops in this area have a total farm value of approximately $70 billion. It has been estimated that if over the next 10-year period if we discontinued research in this general area that we are talking about, that there likely would be a drop of about 25 to 30 percent in the yields of crops in this area. In other words, if we took away -- we would have a backlog, but if we took away any further progress in this, it is obvious with new diseases, new insects -- all these coming along -- this could drop off rather quickly. And this would represent a loss of $4 or $5 billion annually. So it is big business. More

important, if we cut it back this way, we would have a shortage of food instead of a surplus, which we have at the present time. It is this critical.

New technologies from mechanization and improvement of efficiencies in the last 15 years have increased the use of power and machinery by 17 percent. This progress has replaced about 3 million man-hours of labor and at the same time it has resulted in a 22 percent increase in crops. This figure, too, represents about a saving of $4.5 billion to the consumers.

But the need for research in this broad area is big, because almost a third of the Department's State research in this area is almost the same -- 65 percent total. As we rank these under the system for criterion, we have to look at the size and what is in there at present and other things as a basis for projecting ahead what we are really going to do. We are at the stage of looking at this in more detail at the present time.

In this group, if we take the top 20 percent, for example, there were 9 of the ones out of about 35 or 36 that would have come up with a higher rank than the other. There were 8 in the second, 20 percent and so forth. I am using this to illustrate that when we sit down with groups of people under this basis, we do begin to attach importance to these. We have gone through, and are going through, all of these on this kind of a basis. Some of these most urgent ones are: How do soil, water, and air pollutants influence agriculture products? What can be done to alleviate their harmful effects to plants, animals, and man? What information is needed to develop systems for labor, capital, and other investments to maximize profits for different soils and other climatic conditions? How does the biological, biochemical, physiological, genetic, nutritional, and environmental determinants of insects, diseases, nematodes, and weeds influence their development, reproduction? What can be done to develop effective, safe, efficient, and readily useful methods and systems to control or minimize the losses of these?

These are just a few of the examples. Now let's move to the second area which is to protect and enhance income positions of farm families. Research in this area is directed to a better understanding of the supply and demand of farm products, to increase farmers' bargaining power, to improve the structure of agriculture, to resource allocation on the individual farms, to increase income, and to the competitive interrelationships in agriculture.

The basic problems of agriculture stem from national economic growth and the resulting changes in the relative prices of resources. These are long-run problems. Long-run policies are urgently needed, not only to solve the commercial farm problem but also to help solve the parallel problem of rural communities. Current production control programs are accepted because they bolster farm prices, provide monetary rewards for cutting output. Participation in them is voluntary. They have helped control production; they have also increased incomes. But over the long run we continually need to look at this to see what are some of the long-term kinds of things that we need to do to get at the root of the overall problem.

And so in this area there is research being done, coming up with different alternative possibilities that would come near meeting these needs. They are not all the same commodities and they are not the same, year by year. What is needed in this area are people who are competent in policy research to continually look at these, to come up with various alternatives. Then these need to be explained to people. In the final analysis they can reflect themselves through the process of representation so that we will have the kinds of programs that we need to, not only take care of the farm problem situation as far as this country is concerned but also to provide for whatever our policies may be on using our abundance and our ability to produce in the overall international situation.

Now let's go to the third general area -- to enhance the effectiveness of distribution and marketing systems. I think I will not go into detail on this, because you know what these are. I would point out that this is a big business -- actually a multi-million-dollar business. We have made real progress in our marketing systems. It represents maybe 60 percent of the total cost of the food that people are using. Any economies that we can work in here can be very effective as far as the consumer is concerned. And so there are important areas in the marketing area.

It was interesting, as we looked over these for one reason or another, none of them showed up within the 20 percent, none of them showed up within the second 20 percent, and six of them showed up in the third. There are things like this, especially on some of these, that make you wonder whether or not you have done what is really needed. So we have to go back and look at these once we get them together and hopefully come up on the basis of the judgment of the panels and the judgment of everyone else with those that are more important than the others. We screened out most of the ones that we felt weren't top priority to begin with. So we are really looking at the top. It is like taking a class of students in the top quartile and there are some A+, some A, and some A-, but all fairly high priority. This is the situation we are in at the present time.

I think it is not surprising to find this, because continually through the years I think the record shows that in the State experiment stations, roughly 20 percent of the projects are closed and new ones are coming in each year. So this isn't a matter of having a lot of deadwood. And this is true in the Department. No one would argue but what there are real opportunities to improve on this. This is the sort of thing that should make it possible for

us to do as we go through several of these kinds of evaluations.

Let's go to the area 4, which is consumer protection and service. Research in this area is directed to the improvement of quality and variety of existing food products and to the development of new ones. Utilization research is commonly referred to in this area. Here we need to continue to work at what are the physical and chemical components of these raw agriculture food products, what changes occur in these during storage and transportation, and so forth. In the final analysis these farm and forest products are going to have to be used by people, and the quality of the particular product determines how well they go and what people want.

As we look at the kinds of things that are going to be needed as we get into the international situation, the needs and the eating habits and so forth in those countries are different. They are different within regions and within a country. If we are to be competitive in world markets, we need to know what those are and tailor whatever we have. If we are there with the kind of a product that they want, at a price that is reasonable or favorable as far as the others are concerned, we are in business. If not, we are not in business. This is the sort of thing that we need to continue to look at, because with the number of people around the world -- and as these under-developed countries develop -- there will be the potential for markets. If we are there with the kind of product they want at a price that is favorable -- and here is where efficiency of production comes in -- we are in business. If we are not, that is a simple fact of life.

Let's go over to the next item, which is No. 5. This one is headed "Advanced Levels of Living of Individuals and Families." We talked a lot about this yesterday, as to what we can do in order to improve these situations. There has been a disparity. Farm income has been down because of the price situation, because of surpluses. People in these areas have not had the opportunity for economic income that others have had. There have been fewer farms. People have had to move. This is affecting all the institutions in the communities; there are some real problems here.

Also in this area is this business of nutrition. Only 2 or 3 percent of the total research dollars in the Department is going into this overall area. As pointed out yesterday, we probably know better how to feed a pig than we know how to feed ourselves.

The other problem: If we knew what to eat, we wouldn't eat it probably because we like cake and pie. Kids like to have the things they like to have, rather than the things we would like them to have. This is part of the system. Basically, this is a tough area in nutrition research. By and large this is work done by home economists, and we have some real good ones in the area. We don't have as many as we need. But they have a habit of getting married and raising families and this disrupts the thing. So I think if you really get into a strong program in this area -- and I think this is so vital -- I think we have to talk more of the young men into being biochemists and biophysicists and whatever you need from the standpoint of digging deep into the nutritional aspects. Already we have several in this area. We are going to have to move in this direction, and we need to encourage more of the girls to go into this area and take advanced work. Thank God, they want to get married and take care of us. That is fine. But it kind of disrupts the program, if you have had any experience in trying to develop a program in home economics. You know what I am talking about.

This other area of getting at these people's problems from what they need -- we knocked this around yesterday. This is a rough one. Just because there isn't much work being done in this area, as far as I am concerned, is no reason why there shouldn't be. The tools for doing this are not developed like the others. A few years back we didn't have the others. What we need, I think, is to move ahead and consider this a serious area of work and then get about the job of training people.

There are a lot of people that we can pull into this sort of area, and we need a multi-disciplinary approach. We don't need just sociology. We need economists and a lot of other people. There are folks around who are interested in this. When we get into the country-sides, and in towns, too, this business of taking advantage of what we have done from the standpoint of physical resources, we just really have done a poor job in adjusting all these changes. And this involves people. Here is probably the most challenging area that we have -- and probably the most difficult. Because we don't have much in this area, as far as I am concerned there is no excuse why we should not have. As we get into some of the international situations, I think this is even more important. To me this is one area that we ought to really begin to get on top of.

We can't just say here is whatever number of millions it takes to do this, and take off tomorrow. It can't be done that way. It has to be built around a program that will build strength on strength. There are some good people in this area. So we ought to develop centers of excellence, or whatever you want to call them, and get some good people in here and begin to train these boys and girls in this area, give them the kind of training they need so that in 2, 5, or 7 years from now we can have the kind of program we need, and we will not take advantage of the potential use of these things we produce to satisfy people. After all, that is why we do this research. We don't do this production and other research for the fun of it. It is to try to make a better way of living for the people. And until we get this other thing we are talking about, we are not going to get the sort of things done that we need to.

Enough of that. I could talk a long time on this. I am not in this area myself, but have had a real interest in it and have tried to get a

little push on it. I am convinced it is one of the very important areas. I tell our folks that we spend a lot more money working on pigs in our country. Pigs are very important to the State of Iowa. And I might make a Chamber of Commerce speech as George did yesterday about California, but I won't. My argument is that people are important, too, and the changes are going on, and we really haven't taken this job seriously. I think it is one of the things we need to go about.

Community improvement really comes in this same kind of category. We have just 2 percent or so in this area. This is kind of piddling. The tax structure, the education base, the people that do all the supplying and all this sort of thing, the churches and the schools, these are changing.

We have had some experience in a number of areas, very good experience with what you can do here, where you first get the facts. In doing this, it really takes a combination of people that are interested in assembly and research to evaluate these sorts of things. Some people wouldn't call this research, but it is research of a kind that is needed. And this needs to be done with people who are handling the education process. A key to this is getting it, assembling it, getting it out to the leaders, and getting them conscious of the problem so that over time they will take some action.

Experience has shown that if they have the facts, the people out in those rural areas will look at alternative opportunities and will set about the job of doing something about it. This can be done. But we need to take this job seriously. And you need to look at these on area economic base, or some other kind of base like this, that makes some sense from the standpoint of trade area, what they have in there, and the industries they have and the industries they might get and all this. This can be done.

How to do this? The kind of research in this area is not easy to do. A lot of the information is around. It is a matter of putting it together. So it is a combination of research and education. And this is really what we are doing when we go into the international situation. Actually, they need research, they need education. But the big job is the adoption, the variation that we put into whatever we have presently that will work, and to identify those things that don't work. We can't take things out of Iowa and put them into India and have them work. Everybody knows this. We have to look into these things.

Let's go to the next area -- natural resource conservation. I would be tempted here to really give you a speech, because this is an area where I think I have had a little more experience than usual, but I am not going to.

In total, the overall natural resource program is very important because here is our land, our forests, our wildlife, our recreation, and all the things we go down the line that we have. When we look at it, most of these things are out there in these 12 or 100 watersheds that the farmers live on that produce the food and other things. If we don't care for the land, water, timber, wildlife, over time we are not going to have the potential base.

We made real progress in these areas. There is a lot of good work being done. Water shortage is a real problem, and coming up. We haven't done nearly as much as looking at the legal and economic aspects of the land use and the water use and whatever use we are going to have. Where do we put our parks? Where are we going to build our urban areas and highways and this sort of thing? Here is a real area. When we go out into the areas over the country, there is a real interest in long-time comprehensive planning in order to make order out of this business of where we are going. We ought not, for example, to go out and build a big dam where later on we might need this for something else. We need to be looking ahead--20, 30, 40, 50 years ahead. Water, pollution, and the sedimentation that come off of the areas are some items that get fairly high priority as far as the ranking that everyone gave.

The last one--international trade expansion--is a real important area. We don't know how much we are going to do, how much we can do, how far we should go. There is some research in this area but it is nominal. There needs to be more research, so that we can provide the kind of information, for most of these things will be solved around the conference table, a good many of these. But we need to strengthen the hands of the negotiators by providing them the alternatives that might be possible to take off some of the restrictions too, so that everyone in general can benefit from these overall problems. The possibilities in this area for aid as a part of the development process is certainly a real part of it.

I think one of the real important ones in this area, as brought out yesterday, is technical assistance. The Department and the States have a lot of people working in the AID program in various parts of the country. I feel that one of the real limitations to what we are doing is that it is on a 3-month, 6-month, a year, or 2-year basis usually. There are some real long-term aspects of this, and I don't think that we have really faced up to this as an important part of our programs. How much of our effort are we going to put into this? That is just as serious as production or protection for people. Until we do this, until we get this worked into our budgetary system and recognized as such, we are not going to be doing justice to our program at home. If you think you can send 10 people, as some of us have, some place, your key people--and these are the ones you ought to be sending--and not hurt your current program, you have another thought coming. I am sure Al Moseman and others will tell you more about that.

I see my time is up, practically. I had some notes here on this business of basic and applied research. I am not going to say

anything on that other than it is very important. We need to increase it; we have increased it. I am sure it is one of the best investments that we have from the standpoint of providing knowledge to solve these practical problems, rather than do them on a hit and miss basis.

I would like to say just a few things about organization. Actually, we have hardly got into this. We have talked about it, but I would like to leave just a few ideas with you in closing. I think one of the real difficulties that we have had in the State stations and the Department is that we have responded to many requests and many pressures. In the early years of our work it was primarily toward production research. As it should have been. We have responded to these, but in the process we have found ourselves spreading rather limited resources over too many areas.

There are local problems, and regional problems. We need to recognize these. But over time, as we have learned and as we have better communications, we know that many results can be applied over several areas, we need to work on concentrating our efforts over fewer places. We worked on how you get things closed out. That is not simple. But it can be done if we plan ahead and have a good reason why this needs to be done, and work with our people ahead of time. We can avoid many of the difficulties that some of us have got ourselves into in the past on this basis. We need to do this. We need to concentrate in a few areas, probably around these major commodity areas, using a multidisciplinary approach to look at the total problem. Look at the soybean problem. We have an interest in this. About three States have 50 percent of the soybeans, produce them, and about 7 percent produce 80 percent. The Department and the States have a 50-50 share in this program.

What we ought to do is get the technical people and say: "Here is the program, the economics, disease, production. Plan the overall program and get us an administrative adviser or research coordinator, set this out and go after soybeans, pigs, and cattle--you can name 35, 50, I don't know how many--really work at this."

All this won't be done at any one place. We have competency around, but these form a nucleus. We develop enough strength and competence in these areas and this can be done. This makes it possible to concentrate, get enough people in an area so that we can really go into depth in some of these things. As we look around the country geographically--citrus in Florida and the Southwest, and cotton and tobacco and soybeans--we can spread these pretty well over the country and everybody feels that they have a share in this overall range.

I see my time is up. I will close here, although there are a good many other things in these areas that we have talked about and where we will continue on this.

I would say that I think there isn't any question but what we must be real serious about this business of looking ahead, planning together, organizing our programs, coordinating our effort. There are always going to be many more urgent problems than there will be money to handle them as well as we would like to. Therefore, we can't justify spending time and effort on problems that are less important or problems that we have pretty well solved. We can't do this unless we have a long-range plan and program to move ahead.

People get tenure and so forth in organizations. We do have chances of changing these over time if we have a plan. And so if someone retires 5 years from now, we can move. If we don't have it, he is likely to go back in the same thing.

Thank you very much.

DR. NORMAN: Thank you, George. We plan to spend a little time discussing this and to respond to questions. I think I will take the prerogative of the presiding officer to say a word or two at this point.

This study which has been undertaken is an analytical one, looking at what is going on and what are the justifications and what are the needs, through a series of glasses, looking at them in one respect, and then re-examining them in another.

I have been, for a good many years, in one way or another, involved or interested in agricultural research. I think I am troubled by some of this. This is not wishing to discount in any way the enthusiasm and dedication of individuals such as George Browning and Dr. Maclay. I think I am troubled to this extent: One of the features of agricultural research in this country that I don't entirely understand is a certain measure of inconsistancy of objective.

We are formulating an agricultural research program against the context of a political program of the Department of Agriculture. Interests wax and wane and program popularity shifts. What today seems to be very urgent and very desperately needed, tomorrow you don't hear about at all. It is true that we have certain research resources. We have certain funds and resources that we can dispose of to forward the national and human interests in this area. I think I would be a little more comfortable if I thought there was a sort of core program that was not so much affected by the waxing and waning of interest. I would like to be assured by those who know much more about it than I that this fact is so. But it is not clearly apparent to me. I would like to start off asking one or the other of our speakers to respond to that talk.

DR. MACLAY: I think, Dr. Norman, as far as these, we talked about the Department's eight missions. These have just come about, have been enunciated here in the last month. It just happened that the way we had organized this and fit it into those missions, the States, it is not necessarily their missions at all.

The program as we have done it has been

developed completely independently of any of the Department's input into this as far as trying to structure around the mission. It so happens that our classification fell pretty much into those missions. We have thought that there was some advantage to making the two compatible at this time.

Take the grant program. I recall about 3 years ago we came up with the appropriation research program as projected with these new buildings to be available in a couple of years, with an overall program which would be $60 million. It is in the report that we would have 25 percent of that in the contract and grant program--that would be $15 million out of $60 million. Half of that would, as I recall, be administered through Ted Byerly's group, which is all grants. There is no limitation that this go to the experiment stations with the land-grant colleges.

We have had--in the appropriation field at least and I am sure the others in production now--50 percent of contract and grant work will be in grants.

Listening yesterday, I think there is a feeling that too much of it is in this requirement field. Yet as I listened to Dean Price last night, I thought he made the statement that about 10 percent should be in the so-called new field. I think we are not far from that right now. I also recall Dr. Brooks stating that he wouldn't do away with the old or take over completely the new. So I think we are trending in that direction.

DR. BROWNING: I might respond to this. I share your feeling on this, Jeff. I think this has been the general thing that has happened. It is probably our fault in that while we have had these general areas of efficiency of production, appropriation, and marketing, I think we have not really set these out as clearly as we need to.

Work with the people who are interested. Get Congress to the place where they understand better what is in here. And if we have a good case and work at it in these broad areas, I believe that over time we can bring some of this more or less continuous, long-time effort in moving toward this direction.

I think the record shows that we have kind of gone on the basis of whatever was most popular at that particular time. Some would raise the question as to whether or not those might have been the most urgent and the most important ones. But at that time there was an opportunity to get some support on it. We have to be practical. This is the way things get done. If we have a good thing and if we have it organized, if people understand it and we work at it, this can be solved over a period of time. I don't think you can sell anything unless you really have it on this kind of basis.

We like to think that this effort that we are going through might help us to do this. If not, we are wasting a lot of time, Jeff. We are learning a lot out of it, but I really believe that this will and can be used as a very important and a very valuable instrument--having all the suggestions and ideas.

One of the reasons for this meeting is, what are the things we can and should do that will make it possible for us to do a better job in presenting this case, identifying the important areas, organizing them so we can make the best use of all the resources that we have.

DR. NORMAN: Dr. Brady?

DR. BRADY: Quickly looking through on some of the summary tables and making some almost in-the-head calculations, if these figures are correct--and I assume they are and that they mean what they say--I am astounded at the difference for support from scientists in the experiment stations from the Department of Agriculture.

When I was in the Department of Agriculture, I thought it was miserably low. But when I compare in the biological sciences $55,000 per man in USDA, compared to $35,000 in the State--is there some explanation for this?

MR. MC ELROY: Yes.

DR. BROWNING: I found some errors in punching cards on the science man-years. I won't take this too seriously. We have to print this out. It may come out the same way and overall it may not. There is one of the problems that I probably should have talked to. I had a note on it. I think the first priority is to be sure that in our own going programs we have got enough money in there so those scientists and other people can use their capability to the full extent. I think this is what you are saying now. When you add this up with costs of doing research, it is obvious we are not there today. This is hard to get. It is easier to get something for something new than really keep up with your costs of living and get adequate support for these areas. Many of you work in this area know this.

I still believe that we are not providing our people that are working in these areas with the opportunity to develop themselves and get as much mileage out of the manpower. Manpower is one of your real problems. If you don't have good people you are not going to have much program regardless of how much money you have.

DR. NORMAN: Our program is so heavy this morning that I will take one more question, then we must move on.

DR. MEHREN: If you look at table 1, attachment 7, my immediate reaction is that you demonstrated again rather shockingly that the Department's research program has not been inconstant, it has not served the missions of the Department of Agriculture. Because out of $414 million, between the two of us, all except $8 million of it is production, processing, and marketing. This is only one of the politically determined missions of the Department of Agriculture, and it is one in which there is relatively minor activity. But you have concentrated probably 95 percent of the research activity to service one mission of the Department of Agriculture. You have always done this. And the other missions of agriculture have virtually no research backing at all. Is that correct or not? If it is correct, do you like it that way, Mac?

DR. MACLAY: I think 75 percent of this is in the field we call production research. And the rest of it is fairly minor, particularly in the human resources, nutrition, the community development and that part.

To answer your question, I want to put these tables in because we have just gotten new printouts. The real error in this table is in the Department's scientific man-years which is low here.

DR. BRADY: That is a figure that seemed out of line from what I had seen before.

DR. MACLAY: The money part is correct.

DR. BROWNING: I think, George, this is one of the real reasons why you do this. And I am not saying why. What I am saying is that I think we ought to get busy in these areas and do some of the things that some of you economists and sociologists haven't done. Maybe we haven't given you any money to do it. Being a physical scientist I can say this, and smile while I am saying it. But I am serious about it. I think we have done an outstanding job in the other area. I think we have not done nearly the job. It is a tough one, it is a difficult one, and I think we need to give serious consideration to how we strengthen the other areas that I have tried to emphasize when I was speaking.

DR. NORMAN: Clearly this is a provocative topic that we could debate for sometime. As Chairman I have the last word on this. I think I am looking at this through quite a different set of eyes. I am looking at agricultural research as a part of continuum of pure and applied biology leading into technology. Much of the subject matter that is basic, vital, essential to the applications and the technology is common also to other applications and other technologies which relate to human interests, human welfare. What disturbs me and distresses me, I think, is that I do not see this as an evolving pattern of national science programs in this area. I was tempted yesterday several times to try to make this case, but this seems to be perhaps a more relevant occasion in which to make it. Somehow the approach from the application thing filters back from the science, but we ought to look at the science and then from that stem out to the various applications.

I have had my little say. The next topic on this morning's program obviously leads out of what we have been saying. This is a panel that will discuss the adequate supply of farm and forest products. The moderator of this is no other than Ted Byerly, who loves to embarrass people when he introduces them, and really I am very much tempted, Ted, to let you have it, but I think I will not.

Ted has been long involved in the Department of Agriculture as a research scientist, as an administrator. Since 1962 he has been the administrator of the Cooperative State Research Service. He is my predecessor as chairman of the Division of Biology and Agriculture in the National Research Council. He has heavy involvements in the forthcoming international biological program. Ted, will you introduce your co-participants in this part of the program?

PANEL ON ADEQUATE SUPPLY OF FARM AND FOREST PRODUCTS

DR. BYERLY: Gentlemen of the panel, will you please come up front? It will be no embarrassment to have this as their introduction. They will be identified by their participation. I shall try to constrain my remarks to save time. I will remark, however, following the previous discussion, that in my opinion research is done by people, not by projects. One of the characteristics of people is inertia. And it is hard to hurry a man is he isn't going anywhere. The other remark I would make in the same context is this: Here I will quote, from a French author: "In a democracy a young man of merit may be sure of recognition if he knows the right people."

I wrote to the members of the panel and I will read these remarks. They are not instructions to the panel but simply background:

"Our panel at the Airlie House conference will concern itself with needs and opportunities for research relevant to two missions of agriculture. These are: Adequate supplies of farm and forest products, and conservation and development of natural resources."

"Our panel is concerned with items 1 to 13 in the summary table under tab 7. Among the major problems of continuing importance to mission one are: Development and evaluation of nonresidual methods of control of insects, weeds, diseases, and parasites; protection against fire, flood, hail, heat, drought, and pollution of land, water and air; development and evaluation of least cost systems of production of farm and forest products. Relevant to mission two are important problems -- soil - water - plants atmospheric relationships; efficient use and conservation of water; and optimal patterns of multiple use of land, water, ranges, and associated waters. Land, farm, forest, and range amounted to about 80 percent of the land surface of the United States, with the current inventory value of about $200 billion. Seventy percent of all precipitation returns to the atmosphere by evaporation from plants, soils, and other surfaces on these lands.

"Commodity production has a current gross annual value of about $50 billion. The research with which our panel is concerned is chiefly biological research. It constitutes a major portion of all biological research in the United States, especially in the plant sciences, entomology, and parasitology. Researchers on State agricultural experiment stations staffs receive about $20 million in biological research project grants from Federal agencies other than the United States Department of Agricul-

ture. Outside the USDA-SAES establishment there exists a body of biological research of approximately equal volume, differing from agricultural biological research principally in focus and perhaps to a lesser degree in the material used. Agricultural research is mission-oriented, largely conducted with crop plants, forest trees, livestock species and their pests, and with associated land, water, environmental, and rural life problems. Basic research tends to be that which is initiated to obtain information needed for problem solving.

"A major problem obviously stems from these circumstances. How can biological research oriented to the missions of agriculture be integrated with biological research oriented to health, other missions, and to non-oriented basic research without losing its essential orientation to missions of agriculture? Our panel should, in my opinion, waste no time in seeking to persuade one another, nor our audience. Rather we should seek to identify ways in which research resources available for resource and commodity-oriented agricultural problems should be allocated. How can productivity, relevance, and quality of such research be improved?"

I am not trying to structure this panel beyond this letter. I would hope for audience participation, for questions. But in all fairness to my fellow members of the panel and in the order of seating from my right on down, I should ask them each to comment briefly.

DR. JEMISON: Until this morning, as you have noticed, forestry hasn't been referred to very often in the conference. I might take a moment and sketch for you what I think are some of the significant aspects of forestry in the United States.

As you know, about a third of our lands are in forests or in wild land condition. About 60 percent of all of the commercial forest land is owned by 4.5 million individuals, a large proportion of which are farmers, or bankers and lawyers or others who have an interest in holding a small portion of the forest land picture.

Commonly, when we think first of forest land production we think of timber, and of course timber and timber products is one of the important products that comes from forest lands. But today we are in a very dynamic situation in the whole forestry resource field. Not only is the production of timber important but the associated resources of fish and wildlife, recreation opportunity, of forage, and, of course, water are very vital and important parts of the whole forest land picture. So when we think of the productivity of forest land I think we have to think of these aspects, too, as Ted has mentioned.

I believe one of the troubles we have had in the past is adjusting our forward look to the kind of research needed to make forest land most productive and to serve the people who, as I have indicated, own a small part of the forest land picture. We fail to understand the complex nature of the forest resource and the kind of research that it will take to answer many of the problems that will arise.

If you take a map of the more depressed areas of the United States and superimpose that on a map of our forest land, you will see a great coincidence. The forest resource, in other words, is potentially one of the major resources on which we can build to alleviate some of our rural problems.

I believe that we have not properly organized our research; we have not clearly set forth the problems to be solved. I would like to emphasize what Chancellor Aldrich and some of the others pointed out yesterday, that one of the best approaches to a more productive forestry research program will be to identify these problems clearly, to organize problem-solving groups -- call them teams if you wish -- that bring together all of the disciplines that can bring intelligence to bear on this complex multiplicity of resource opportunities that come from the forest land resource.

We have restructured our program in the Forest Service. We have tried to start with a sharp identification of these problem areas. We have tried to bring together into groups, people with skill in the various disciplines that bear on this multiple aspect of the problem, with special emphasis on how we can make the rural forestry resource pay off in terms that we feel it can do in elevating the economy and benefiting the society of rural America.

DR. ECKLES: For those of you who are not acquainted with me, I am Howard Eckles, and I am the principal assistant to the Department of Interior Science Advisor, Thomas Bates, who was scheduled earlier to be on this panel but was required to return to Washington to be at a Senate hearing this morning. I am attempting to fill his shoes and it is a great pleasure to be able to do this.

To speak only briefly, I would like to raise a question between the research and the development and the action programs to produce forest and farm products in the area which we choose to call conservation.

In looking through the background materials that Ted gave to us to help prepare for our short remarks, it is very easy to determine that the programs of the Department of Agriculture now and in the future are heavily oriented towards the production side, which is as it should be. There is, however, a growing recognition on the conservation side which, for sake of discussion here, I will define as those natural phenomena that occur when you get through with the agricultural side -- that is, your natural streams, grants, forests, woodlands, fish and wildlife, and so forth that God gave us before we turned our land into one of agricultural production.

To be a bit controversial on purpose, I am not sure that the outlook of agriculturalists is strongly dedicated to this conservation side. I can use my own Department as an example so that I won't point the finger too strongly at

those outside the Department, where, in the area of land management, we use drag chains and bulldozers and various methods to clean off acres and acres of ground to get rid of sagebrush and scrub pine and so forth, and turn this into forage and grassland.

I am not sure what criteria are back of this, as to who decides whether or not we get a better type of environment by doing this than leaving it as it was naturally. Who decides whether or not the rabbits and the squirrels and the snakes and the insects that live there aren't, at least in some measure, as important to us as the new production that we gain? And who is keeping track of the balance or the changes that are taking place naturally and that we ourselves are causing, so that we do not eliminate species of plants and animals, so that we do not eliminate important environments that we might want to use 25 or 50 years hence? I think we have to give more than lip service to this type of consideration.

Our success at production I think has been phenomenal. Now we are coming to a stage where we are beginning to appreciate more and garner that part of the environment that is not in production, that we will devote scarce dollars and scarce manpower into the research, the development, and the action programs to protect this part of our heritage for man's longterm use.

My question then is: How serious are agriculturalists about the total balance of nature and the conservation aspects which are now listed in your program?

DR. BYERLY: May I make a remark and this is half addressed to Geoff. I will paraphrase the Biblical term "It is more blessed to give than to receive," especially when you are holding the needle.

DR. NORMAN: No comment.

DR. BYERLY: The question here is this: We are natural enemies, us farmers and you wildlifers. In the Great Society we have to work together. We have no choice. How do we do that? One of the things which is of mutual concern to us is that we work with the same establishment in the country. In the experiment stations there is a great deal of research on wildlife. We support some of it, you support some of it. We do work together in the experiment stations and in other places. How, other than through personal contacts -- you and I see each other frequently; we don't do any research -- how do we do this better?

DR. ECKLES: I have the problem back in my lap and I think it is appropriate. That is where it belongs at the moment, since I raised this issue. I am not sure that I have a complete answer to Ted's question. But one way is to increase the dialogue between ourselves, who are all interested in working in this field of biology. I am not sure there has been enough information, particularly at the long-range planning levels of the whole planning structure. The information which we have learned about what the Department of Agriculture does through the various Federal council committees -- and now more recently through this planning and programming and budgeting system -- is certainly a step in the right direction.

We have the same kinds, in general, of program categories within the Interior Department as shows up in part in the Department of Agriculture. These ought to be examined, discussed, and then the common elements in the essential parts planned and carried out in concert wherever this is possible. We must spend a great deal more time at this than we have in the past. I think the recognition of the commonality is obvious.

There is another aspect of this that is also of significance. We have come to recognize more and more -- at least I have personally -- in the last 2 to 3 years -- that there is no real good substitute for high interest. If you have a job to do, set this group out to do it and let them use all of the various kinds of tools that they need to get that job done. Reduce the number of constraints on an operating group so that it can go right to its job.

But while you are doing this, keep everyone adequately informed and share and cooperate together if you can. I know this sounds rather pious because the edges can get very fuzzy. I think you won't really accomplish this mission if the Department of Agriculture, and the agricultural system, was converted, so to speak, to be only conservationists. Then you will lose the agricultural mission. I would rather have the Department of Interior here with a needle to keep working on the conservation angle. I think the country will come out better. We will push our interests and our mission, because we are personally motivated to do so. But we have to do this in an area of cooperation.

DR. BYERLY: I want to continue this needle. I think it is a very important thing, and one of the reasons why you are on this panel. Let me recite an anecdote, or two of them. First, because there was an area in which there were some ponds, I sought to find information on trout ponds. So I went to the Fish and Wildlife and they sent me a bulletin. The bulletin was prepared in our Soil Conservation Service.

DR. ECKLES: No comment.

DR. BYERLY: I was present when Senator Fulbright in his very persuasive manner sold an authorizing committee on the need for a fish culture laboratory at Stuttgart, which is now in being, and I am glad it is there. He sold it on the basis of what the broiler industry had done for the State of Arkansas.

A third example. There was a fisheries expert who went with the Secretary to Vietnam. He is an employee of the Auburn Experiment Station and he is very good. I would say that agriculture is very seriously interested and has certain competence in this area. So let's get together.

DR. ECKLES: True, Ted, but you are still only producing food.

DR. JEMISON: Let me speak to this.

DR. BYERLY: Here is a man who wants to talk about habitat.

DR. JEMISON: Since you spoke about the great gap between Interior and Agriculture, and since I am in agriculture, I feel compelled to rebut you a little bit on this. As you know, the Forest Service does have a substantial interest in the management of wildlife and fish habitat. We have a small but growing research program in this area. I believe you have approximately 26 cooperative wildlife units that you maintain, where you maintain wildlife biologists at university locations. I think in at least half of these your people are working closely with Forest Service research biologists on common problems.

At Olympia, Wash., where we have an animal damage laboratory to find out how to correct what is now roughly estimated at $50 million damage to the timber crop in Oregon and Washington each year, we have housed for at least 10 years your Department of Interior wildlife biologists, working hand in glove with them, your people on animal biology and our people on the vegetation phases, closely coordinated with your Denver laboratory, where we have made grants over the years to help finance the Interior Department's activities.

I am only mentioning these, and I could give you a lot more examples, such as the very effective work you have done on poisons for range rodents that are very damaging on our mountain and forest range in the West where we have been working again on the vegetation ecological aspects, where you have helped with developing rodent repellants which has made direct seeding in Southern Pine possible, saving hundreds of thousands of dollars a year. I mention these not to suggest that everything is perfect, but to emphasize that there is an avenue open to this team approach that you mentioned which is very desirable.

In answer to your question of how are we going to determine what should be the balance between saving natural brush-covered range, say, versus clearing it off and reseeding it, I think this is a job for all of us to sit down and try to project ahead what the likely supply and demand situations are for all of these resources combined, and then structure research programs that will put together into a package a real comprehensive job that won't leave out any aspect.

DR. ECKLES: Mr. Chairman, there are two speakers --

DR. BYERLY: I want audience participation, too. The panel has responded and you have done your job most effectively. Are there any questions or comments to Dr. Eckles' remarks?

DR. EMERSON: I am not concerned about the coordination at the government level in Washington and so forth. I am concerned when you go out into the rural areas and you find a farmer who has adopted the practice of clearing his stream borders and clearing the last brush off his land so he can get more cultivation.

I am concerned with the point you brought up, that maybe this isn't coordinated at the local level. Do you see any improvement here? This has been true in the past. I don't know in the last couple of years.

DR. ECKLES: I am not really sure that I understand your question. Is it that the farmer has the right kind of information as to whether he should clear this brush or not?

DR. EMERSON: Yes.

DR. ECKLES: I think it depends on what his objectives are. If he wants to protect wildlife in his area, he ought to have a wildlife cover for them to live in. He won't protect wildlife if he takes the cover away. If he wants to have farmland, that is another thing. It is a question of the criteria.

DR. BYERLY: Let me give a categorical answer. Our Soil Conservation Service, in concert with the Soil Conservation Districts, seeks to persuade farmers and pursuade themselves that it is a good idea to maintain wildlife habitat along their streams as a part of their undertaking. I think there is a growing awareness and I think there is some growing practice in this direction. Nyle, you are familiar with this more than I am.

DR. BRADY: I don't think there is any question but what you do have, particularly among the Soil Conservation Districts, a movement in this direction. I think the point made here, right within the same department that is moving in that same direction, a farmer can get help to drain land that will make it impossible or impractical to consider it as a wildlife refuge. This is real. So you have two arms of the same department that seemingly are working in conflict. Again, Ted, it goes back to the farmer, the individual. Which does he think is more important, raising rhubard or wildlife? The decision is up to him. The mechanism for him to go in either direction is there.

DR. ECKLES: I can't resist making one comment on George's remarks, to bring home the point that I have been trying to make. It is true that we have this extensive cooperation in the field among the wildlife biologists and others. But my contention is that the agriculturalist and the forester are more interested in the $50 billion they are going to save because they prevent bears from scratching trees than they are interested in the bear. It is a question of your outlook.

DR. HAWKINS: Gentlemen, with that take-off place, I will try. I am Louis E. Hawkins, Director of the Oklahoma Agricultural Experiment Station, and Chairman of the Experiment Station Section of the National Association of Land Colleges and State Universities, vice versa in order, incidentally.

I thank the hosts, and I thank you colleagues for the opportunity of visiting with you. I suspect I could help you best by sitting down promptly, and I shall do that real shortly.

If I held strictly to the subject of the panel I would say we are providing adequate supply of farm and forest products. I could say, but it wouldn't be adequate to say, just keep on doing what we have been doing. It is never adequate to continue just to keep on doing what you have been doing.

We have not accomplished it today by keeping on doing what we were doing. We have continually updated, revised, renewed, improved our program of research. And it is continuing practice currently for at least 20 to 25 percent of the program of the State agricultural experiment stations to be renewed every year -- by termination of some projects, by initiation of new projects, and by updating of continuing projects.

At this stage permit me to briefly say, if I may elaborate two words, sir: True research is not accomplished by projects. Research is accomplished by researchers. And gentlemen -- not "but," but "and" -- research is accomplished via projects. Researchers don't accomplish much research if they don't have some objectives, some envisioned procedures, some determination, and dedication to achieve results.

Let me briefly, without elaboration, because elaboration is not necessary, do a little bit of commenting within the framework of the subject of this panel and say to you, my colleagues, that administrative responsibility must be exercised in research. And that includes fundamental control by the program administrators.

Obviously I will be talking as a State experiment station director on exercise of responsible administration in the past two decades. Gentlemen, a rose by any other name, you know, is still a rose. So irrespective of the labels you put on it, in a sense, irrespective of the way you cut it, it still is a program or it is not a program. And if it is a program it is going to include an organization by discipline, an organization by technical subject area. It is going to include a cross-organization by commodity or functional area. And this latter, this cross-organization by commodity or functional area, is going to be a team job.

I am not talking hypothetically. I am not talking academically. I am reporting practice. I am saying to you that in this manner has the research job been accomplished and continues to be accomplished for an adequate supply of farm and forest products.

Friend George, when I remember whoever was speaker at the moment, I said over my shoulder to you and Russ Thackrey late yesterday: "All it takes to do is just do it." It is that simple -- to get the team of researchers together and keep the green light on for everyone of them. The opportunity is unlimited to the individual researcher.

A third facet of this program -- call it what you will -- is pioneering research, or funding the individual researcher. It doesn't matter what you call it, there is a place for it and there is an absolute requisite for it. Some individual imaginative people, researchers, if you please, even operate as prima donnas -- provided they are productive. But we are just not about to allocate inadequate dollars to somebody just to play around, or just to develop a program for his own amazement. It is not in the cards. There is not that much money. We have to preserve and encourage initiative and insure maximum production.

This reference and productivity cooperation between State and Federal has been going on for years. It is being improved and increased in productivity. I would call your attention to the yellow tab no. 2 in the text that our presiding officer referred to this morning. You will see that the authorization in the organic act of the Department of Agriculture and the basic mission of the State experiment stations under the Hatch Act are so overlapping as to be virtually duplicative. Hence, planning together is an absolute must. Life is too short and money too scarce for us to do wasteful duplication.

I report to you gentlemen with expression at every opportunity I can make that I have the greatest appreciation for this joint committee that is conducting this long-range study. Here is a joint committee primarily of administrators who are doing a real hard job. It is the first time in history, gentlemen, that a real thorough-going hand-in-hand combined effort of State and Federal looking, thinking, and planning is really being effectuated.

There have been some efforts made previously. There have been some dedicated people who have tried it previously with some progress. But this is the first time there is a genuine joint combined effort at this job. So there must be a program; we must know where we are. When you begin to pick percentages on this category of work and inadequate percentages on this category, it is not that the dollars -- the arithmetic of which figure out 65 percent of the total -- have been squandered on production research.

I submit to you that adequate quantities of food and fiber of the highest quality known to man is a fabulous return for the investment on this production research and efficiencies of production in these United States.

There are inadequacies in other areas. But it is not due to these other areas being neglected or the successful program being at the expense of other areas.

Finally, and I think this is real pertinent: You noted earlier that the arithmetic in this preliminary printout indicated a substantially larger expenditure per man-year per Federal employee than per State employee. That is inevitably true. State employees are underemployed in this job. Let me take a minute more of your time to insure that you don't misunderstand me. To do an effective job of instruction on the campus, to do an effective job requires a relatively large number of specialists. Similarly, to do an effective job of research requires a right considerable number of specialists.

These two jobs, particularly in the past 15 years, are being done and have been approached on the campuses of the willing institutions and within the States in such manner of assembling staff that the total inadequate fund support in the States allows less than an adequate support per man for research. It is a fact.

Conversely, research output could be doubled by addition of only 50 percent more money. Research output in the States could be greatly extended and increased by relatively small additional support to these same personnel. It is being erroneously said -- and it definitely is an error -- that we would be hard put to man an expanded program of research. That is totally untrue, because we currently have the research personnel, the project leaders, the principal investigators to do a substantially expanded research program without increase in the caliber of personnel. We need additional personnel, junior scientists, additional young men of graduate student status, additional personnel of subprofessional grade. We need additional supplies and materials and physical structures. And in time we shall need to expand our professional personnel. But currently the acute inadequacy in this field of work is fund support in these supplies, materials, subprofessional help, and junior caliber help to go with our present senior staff.

Thank you. You can make your own elaboration on these things.

DR. BYERLY: Thank you, Lou. Dean Palm, will you wrap it up?

DR. PALM: Ladies and gentlemen, having been unfortunate enough to miss the program until last night, I may make some comments that were already made yesterday, and if I do, I trust that you will forgive me because they are things that are of concern to me.

One of the problems that is constantly in the minds of all of us is the public's image of agriculture. It is certainly changing. I think to most of the people in the street agriculture is still farming. As we have talked here and as I have listened to the discussion last night and so far this morning, we are covering the whole breadth of modern agriculture from the time of concept of an operation to the final utilization of the product. This has brought to bear many of the sciences -- biological, physical, and social -- that underpin technology with which people must deal in and accomplish these objectives.

I think one of the things also that Dr. Price brought out last night, the great rapidity of change, particularly in the past two decades, has changed the traditional concept of agricultural research with which I grew up and with which many of us are still working, to one of broadened, perhaps less feeling of security, because of the great diversity of it. The breaking down of traditional lines of administration, and the necessity of this, the necessity for further imaginative approaches to utilization, the need for a common core, as I see it, reside in the men and women trained in these basic disciplines, who are working together and who are willing to sit down together and discuss problems as they arise and bring their best judgments to bear on what the processes should be.

I think we will see more and more of this changing, rolling, continuous "fluid drive" type of administrative leadership if we are to fulfill our mission in the job ahead in the production of food and fiber and the protection of our environment and so forth, particularly in the growing world.

The ability to overproduce has been demonstrated in certain commodity areas. The government is mixed in with agriculture, and I think it will always need to be. At times in the past 2 decades we have had considerable confusion for the average person in the lay public of being paid not to produce and so on. These all have had a depressing point of view, I think, on the part of the public in supporting agriculture.

We thought of agriculture research for the most part as being public supported, and I think we must keep in mind that every day more people are born and fewer and fewer of these will ever have had any contact with the farm. So we have, in my judgment, one of the big problems ahead of us -- that of communication.

We must constantly tell the story of what agriculture is, the breadth of it, the research, and the fact that research in modern agriculture is a partnership. It is a continuing one between government, State, and Federal levels. At the Federal level our traditional levels of support which we have mentioned are being challenged. They have not grown as much as the grant-type program. I don't want to get into that, other than to identify it. I feel very keenly that the work and support of the basic areas of our sciences with the granting agencies is one of the great strengths that we have and can look forward to. We need to have an appreciation on the part of the scientists receiving this help that they also will be willing to share in the training of students and in consultation.

We need also those to interpret, to take it on through the practical areas. So we have industry, and this is an area that I haven't heard mentioned this morning. Industry has a tremendous role. It is playing it now. It will increasingly play a tremendous role in modern agriculture through inputs and through those services from the time of production on to consumption. Industry is going to play, I think, a very important role in world agriculture. At the present time the National Academy's Agricultural Research Institute is making a survey with industry to attempt to put a more valid dollar sign on the contribution that industry in this nation is making to the field of agriculture research.

Speaking as one from a university, I feel that the training of future workers through the research programs and by people engaged in research as teachers is one of the great contributions that must be made. It is one of the privileges of the university. I think this is something that cannot be overlooked. In this conjunction, the work of the granting agencies is adding to, I think, the future strength of agriculture, because it is enabling us in the institutions to provide leadership

and support for key people in the disciplines during a training period that will enable them in the future to fit into their particular roles as cooperators, as partners in this program.

Commercial farmers' needs are great. We are finding that many commercial farmers are way ahead of our researchers. I think this is true of the key commercial farmers in most areas. They have to be. It is their whole livelihood. And they are going direct to research people. The time lag between the 3, 4, or 5 years in research, and writing it up as a bulletin and getting it out has vanished with most of our commercial farmers. They use the telephone. They fly in. They do anything if they have a problem, and they are willing to take the risk. Many of them are educated to the point where they understand what the risk is and they are going to take it. So I think we are dealing with this concept in the future more and more in our research planning and implementation.

The President's panel on environmental biology has made a good report. I think it is creating a great deal of interest -- certainly in all quarters. And I am sure that much study and debate will come from it. Agriculture has an important part to play in this whole field of environmental biology, and I will let it go by making that comment because it has been discussed here and time is short.

Natural resources is another area, also the multiple-use concept of our resources. We have just gotten out a brochure on the promise of New York's rural resources to tell key leaders and the lay public that agriculture has developed a strength. It is still producing and producing at a higher rate because of efficiency, technology, and all the facts known to us. And at the same time it is releasing more and more land and other resources for the needs of a growing population.

But we have to be certain that in the planning that must come for the use of these resources to keep this Nation strong as it grows in population. We must be certain that agriculture's needs are represented in the planning that goes into the future disposition of these resources. I think this is something again. Coming back, we have talked to ourselves too long, too often, and we have not talked enough to those who will have the final decision -- the general public.

Another one that we are taking up in communications is the one-man one-vote concept, with our agricultural leaders forum within a couple of weeks, and bringing leaders from Federal and State government, the governor, junior senators, and others, in to talk about these problems so that we have an opportunity among our leadership. If we are going to continue to expect financial support from legislators and States and Congress, I think we must do our best to see that they are informed on the issues and needs.

The regional development of agricultural research is another concept. I don't think that we can afford the luxury of thinking we can do everything at every station any longer. In fact, we aren't. I think we need to speed up and to cooperate in the regional planning and conduct of research which will mean there will be certain centers of excellence in various fields and it will be a coordination of it.

I would comment one word in closing. Through the pleasant association with the Agriculture Board and Agricultural Research Institute of the National Academy of Science and the National Research Council, it seems to me that this organization offers an opportunity for a continuing forum for the study and discussion of problems of national and international significance in modern agriculture. The Academy has the unique ability to bring together panels of scientists and other leaders throughout all walks of life, to come together and to look at problems, to study, to argue, and to finally come up with decisions and to report them. It is an example, it seems to me, of the teamwork that is needed to bring the best brains in our biological, our social, our physical sciences, industry, government, and so on, together, to take a look at the national and international level. We have attempted this recently in terms of pest control. We have to be prepared for decisions that will have to be made. We are not going to be right all the time. No one has ever been that good.

I would like to stress that the program of planning and research is an essentiality of a strong communication system for clarity of purpose to tell people what we are trying to do for and in their behalf and with their cooperation. Thank you.

DR. BYERLY: Gentlemen, the time has gone. You have heard the word. Mr. Chairman, it is yours.

DR. NORMAN: I was about to give you two minutes more, Ted. But since you said that the word is there, if this morning's program isn't to get badly out of schedule, I think we had better adjourn now for the break.

(Recess.)

DR. NORMAN: We will now commence with the panel on economic and cultural aspects of advancing technology. The Moderator of this panel is Dr. M. L. Upchurch, who is administrator of the Economic Research Service in the Department of Agriculture. He has had a very interesting career. He was educated in Texas, later in Wisconsin. He has been with the Department of Agriculture since 1939 in a variety of important positions.

Dr. Upchurch, will you introduce your panel? We will divide the remaining portion of the morning into two 40-minute sections.

DR. UPCHURCH: Thank you, Mr. Chairman. In view of the time requirements, I express one regret. The subject of this panel could very well consume the entire time of this conference and more. We have a group of three distinguished people--Mr. McCabe, I understand, could not be with us. So I shall be very terse in my remarks, and I have asked the panel to be terse in theirs. I hope in the 40 minutes allotted to this group we can have some time for audience participation. I and the panel are planning for this.

Let me say by introduction that we have on the far right Dr. Vernon Ruttan, who is the current chairman of the Department of Agricultural Economics, University of Minnesota. Next is Mr. Stanley A. Cain, Assistant Secretary for Fish and Wildlife, Department of Interior, and next is Dr. George P. Murdock, Professor of Anthropology, University of Pittsburgh.

Let me open this panel by a couple of very brief observations. It is trite, of course, and especially trite to this audience, to say that we are in the midst of an agricultural revolution. In my own terminology, I think we are in the midst of about four simultaneous revolutions, each of them progressing at somewhat different rates.

I will introduce the topics by making a few general observations on the cultural and economic impacts of advancing technology.

The state of the art, of course, is changing all the time. This is part of the purpose of agricultural research -- to change the state of the arts. One observation that has already been referred to is the fact that we do have in the United States fortunately, a prodigious output and the potential for an even greater increased output with our present state of the arts. And I believe that we are going to see more improvement in agricultural productivity over the next 10 years than we have seen in the past 10.

Point No. 2 is the fact that the number of farms producing farm commodities has declined sharply in recent years. A few years ago we used to hear some people bemoan the fact that agriculture wasn't adjusting to modern conditions. Agriculture as an industry has adjusted over the last 20 or 30 years as rapidly as perhaps any industry in the whole history of the world has adjusted. We changed from something like 6 million farms in 1930 to about 3 million now. Along with that, of course, is a concomitant decline in the number of people on the farms.

A third point is that, in this change in the structure of farming, about 1 million out of 3 million plus farms at the present time are producing something like 82 percent of the farm products that go to market. A little more than 2 million farms, then, are producing the remaining 18 percent. You can readily see many implications to this

A fourth fact that I would like to point to here is the very rapidly declining use in labor on farms. Farming is hard work. It still is hard work, despite the help of modern machinery. But nevertheless, since 1940 the total man-hours of labor consumed in producing farm commodities on farms has declined from about 40 billion in 1940 to about 17 billion in 1965; over the same period we had an increase in total output.

Point No. 5 on this is the migration of people out of farming, or off of farms. This doesn't always mean that these people have gone to cities. Nevertheless they have dropped out of the statistics of our farm population. Within the past 5 years we have had something like 800,000 people annually disappear from our farm population.

Point No. 6 is that in recent years the number of people engaged in our hired farm labor force has remained relatively stable. But the character of that hired labor force has changed rather drastically. About a third of the farmwork performed by hired farm laborers is performed by people who worked less than 20 days a year in agriculture. These are what we call statistically the casual farmworkers.

Point No. 7 is that farmers themselves are increasingly doing more off-farm work. About a third of the income available presently to farm people comes from non-farm sources.

Point No. 8 is simply to point to a paradox in our modern agriculture. With a prosperous nation, with a highly productive agriculture, with a few farms doing very well, we have, however, throughout rural areas a widespread problem of poverty, under-employment, and, along with it, a widespread problem of deteriorating rural communities.

These are facts--I am not going to comment further on them or try to evaluate them. With these facts in mind I am going to call on our panel to express their ideas or questions, and then use the remainder of our time for audience participation in this general field.

First, let me call on Professor Murdock for his comments.

DR. MURDOCK: I am going to take seriously the instruction and I am going to make one point. This will take off from the statement made yesterday morning by Dr. Seitz and eloquently supported by Dr. Aldrich; namely,

the question of the utility of social or behavioral sciences to the civilian agencies of the Government.

I am going to make a very blunt statement in conclusion, and I think since very few of you know anything about me I had better identify myself a little more clearly.

I am really here not as professor of anthropology from the University of Pittsburgh but as Chairman of the Division of Behavioral Sciences in the National Research Council. I happen to have had formal training in practically all of the behavioral sciences. I specialized in economics at Yale as an undergraduate. I went to Harvard Law School for a year and a half and left because of the lack of sophistication in the behavioral sciences that I found there. I went on to the graduate school in sociology and anthropology, and to some extent in political science. I actually have my Ph. D. in sociology. I am a practicing anthropologist. Since I have had my Ph. D., I have absorbed some professional knowledge of three other behavioral sciences -- experimental psychology, with a special reference to learning theory; linguistics; and personality psychology, with a special reference to psychoanalysis.

With this varied background I know something professionally about all the behavioral sciences fields. So when I hear skepticism raised about the utility of the behavioral sciences as has been raised here by Dr. Mehren, Dr. Upchurch, and others, I can sympathize with this. We are weak in many areas.

We have some areas of strength. In some of these the strength is as great as it is in the most advanced biological and physical sciences, but these are relatively few. Therefore, when we are called upon to cooperate in applied research, we are in a strong position here and there, but by no means across the board. Why is it that we have made a lesser contribution in the Government and its agencies, especially its civilian agencies, than people like Dr. Aldrich feel we should make? I think there are two reasons.

First of all, with the exception perhaps of economics and psychology, most of the behavioral scientists have stayed aloof from practical -- particularly governmental -- involvement. Some of us, including most of those in my field, are "holier-than-thou" pure scientists.

Among many in the behavioral sciences there is a great reluctance to go into the Federal service, as contrasted with the biological and physical sciences in which many eminent men have been recruited by the Federal agencies. These are relatively few. I have a special prejudice myself: At no time in my life would I have accepted a position in any Federal agency at twice the salary I was getting in the university. This, I think, reflects our "holier-than-thou" attitude.

I think the result of this has been that the social and behavioral scientists that have been recruited in the Federal agencies have been below par in quality. I think perhaps our field is the only one in which one can say that -- I believe I am correct in saying this -- of the about 30 members of the National Academy of Science that come from the behavioral sciences, not one--with the exception of the Smithsonian Institution--is employed by a Federal agency. This is quite unlike the situation in some of the other sciences.

The second block has been a difficulty in access to the behavioral science for the help they could potentially give to agencies like the Department of Agriculture. This has been corrected by Dr. Seitz. A little over 2 years ago the old, relatively inactive division of anthropology and psychology of the National Research Council was converted into the present Division of Behavioral Science by the inclusion of economics, political science, linguistics, sociology, and several other disciplines. So that the National Research Council represents all of the major behavioral science fields, with representatives chosen by the various disciplines.

I am going to suggest that the Department of Agriculture or any other Federal civilian agency that feels there is a possibility that they require advice and assistance from the behavioral sciences do so through the National Research Council, and I am going to close with one concrete recommendation. One of my colleagues in the division is Dr. Kingsley Davis, from the city called Berkeley, in a State which all Californians apparently have been ashamed to mention. He will succeed me on the first of July as chairman of the Division. He is an outstanding demographer, a student of population. He is probably the leading demographer in the United States, if not the world.

It was made very clear here that a major problem of the Department of Agriculture in its foreign activities results from the dilemma that Malthus first presented. The fact is that productivity of agriculture can increase at best at an arithmetic ratio, whereas population potentially can increase at a geometric ratio.

I feel that in view of the urgency of knowledge on population from the point of the foreign program of the Department of Agriculture, it would be inexcusable if the leaders in the Department did not take advantage of this outstanding resource in the Academy for guidance in the population aspect of their foreign program.

This is all I have to say, and I thank you.

DR. UPCHURCH: Thank you, Professor Murdock. My apologies for not introducing you with your long and distinguished record in the field of behavioralsciences. I eliminated this introduction in an effort to save time. You have several inches in Who's Who, and these people can look up this record.

To push on, I am going to call next on Professor Ruttan. Before I do that, Mr. McCabe

has joined us, and I will let him catch his breath and appear last on the panel. Next, let me introduce to you Professor Ruttan, head of the Department of Agricultural Economics, Minnesota.

DR. RUTTAN: Before I begin, I would like to make one observation with respect to the role of the individual in task-oriented research as compared to professional-oriented work. If you look around, at least in my field, you will find that the people who have involved themselves heavily in the team of task-oriented research have at midcareer become professionally obsolete as compared to the people who have oriented themselves professionally. I think this is a very serious problem for the kind of thing we have been talking about the last 2 days.

Technological change in agriculture represents a major policy issue in almost every country in the world. In most countries the problem remains as in the time of Malthus -- how to reduce the pressure of population on food supplies. In the United States for more than 3 decades the problem has been how to relieve the pressure of food supplies on population. In spite of the growth, the outpouring of enthusiasm for food aid, I am convinced that the second problem will remain a significant issue in all major industrial countries over the next several decades. An industrial economy appears to be a prerequisite for an agricultural surplus.

In making this statement I am expressing a judgment that the level of food aid which we have had over the past several years has been larger than our capacity to administer without having negative effects on production in the countries receiving food aid. I anticipate that this will happen again as we escalate the food aid to the levels that seem to be consistent with the Indian situation this year and next. I expect that we will continue to have higher levels of food aid.

Before technological change can show up in the form of high growth rates, or potential growth rates in agriculture, certain prior events are necessary. The stage must be set by inventions or by scientific discoveries. Setting of the stage requires a very high investment in the development of specialized human resources and the organization of research organizations. These investments are relatively small, however, compared to the investment in commercial and public interstructure development that is necessary if the new technology is to result in rapid rates of growth and aggregate output. The initial investments in scientific manpower and organization, however, are extremely important in spite of the relatively small magnitude. They are important because the supply of scientific manpower and organizational capacity is, in economic terminology, highly inelastic.

When technological change occurs, its effects are felt in many ways. For purposes of economic analysis, three aspects are particularly significant. First, changes in production cost and the product mix of individual firms must be profitable if the innovations are to be adopted.

Secondly, shifts in the demands for inputs by innovating firms, as a result of the new profit-making opportunities, must be accompanied by the growth of public or private sector firms capable of supplying these inputs.

Finally, the changes in the total level of resource utilization in relationship to the level of output for the economy as a whole results in a change in the level of output. For the economy as a whole, all cost-reducing innovations become, through the operation of the market, output-increasing innovations. The significance of this statement is that a slight lag in agricultural productivity is extremely expensive, a slight lag relative to needs is extremely expensive. A more rapid rate of growth, even a slight, rapid rate of growth of output relative to need, has very little marginal value.

In the less developed countries and in our own past history, the significance of technological change for the growth of agricultural output, and for economic growth in general, is that it permits the substitution of resources with an elastic supply -- fertilizer, for example -- for resources with an inelastic supply. Another way of putting it is that it changes the plant, for example, so that it responds to conditions that man can control, and reduces its response to environmental factors.

Finally, it permits the institution of knowledge embodied in new varieties, new practices, and other factors for resources in the aggregate. It reduces our total dependence upon resources. I think that the significance of continued technological change in Western agriculture is sharply different from what it has been in our own past, and for what it is in the underdeveloped countries.

In the United States in particular, technical change now gives an opportunity for that part of the population engaged in the production of food and fiber to participate fully in a level of material and cultural consumption that is available only in an open growing industrial society. Note that I refer to the production of food and fiber and not to agriculture. Just as the new theologians are proclaming the death of God, I suggest that it is time to look forward to the death of agriculture--at least as a social and economic system. In the U.S. I look forward not in distaste but anticipation for a modern food and fiber-production industry composed of 50 to 100 thousand firms operated by technically trained management with an organized, unionized labor force, closely integrated with the farm supply and distribution sectors. I would anticipate that such a system would have to compensate the managers and technicians who produce our food and fiber for the disadvantages rather than the presumed advantages of decentralized or rural life.

DR. UPCHURCH: Thank you, Vernon. You certainly have given us a challenging idea.

Time is getting away. I will next call on

Dr. Stanley Cain, who is Assistant Secretary for Fish and Wildlife, Department of the Interior. Dr. Cain.

DR. CAIN: Mr. Secretary, Madam Secretary, gentlemen: I think that the panel speakers, as other speakers, are like gas -- it can expand to occupy a given volume. We could expand to a given space. But when you have to be contracted a little, heat generates.

In order to save time I have put on the board two models -- one a very simplified biological system model, for the sake of pointing out that the problem faced by all life is the problem of energy and matter. And that whatever the problem is for an individual organism, it is solved in relationship to other organisms and to the environment which makes up the system. This kind of a model could be shortened only by having the green plant directly composed.

The other model is an attempt to illustrate a human ecological system rather than a natural one without man in it. Here you will notice that the words are essentially terms that come out of economics -- land and labor, capital and institutions, and economic utilities of the goods and services. For these purposes I have to redefine a bit.

Labor consists of all of the personal means of production. Capital, in this sense -- excluding land or natural resources -- includes all of the man-produced means of production. And land, then, includes all of the non-man-produced or natural-given resources.

The point of this diagram is that modern man -- I guess any man with a level of social development--operates not as an individual; he operates through the organizations of society.

Each of these terms is extremely complicated, as one would know, and capital would be divided between that which is private and that which is public. Everything we do is institutionalized, in terms of science, industry, business; in terms of law, religion, family life, and in terms of all the rest of the things which you think of.

This system -- this human system -- faces the same problem, and that is the pattern in this problem -- its acquisition, its utilization, and the disposition of its byproducts. From the point of view of the biological aspect of this, you are always confronted by the loss of energy by long wavelengths into space. You have the biological problem in the human ecosystem but you have another one, and the other problem concerns the energy that is involved in the tools which man uses and in the operation of institutions which he has produced. You also have the materials problem so that you have two sets of matter and energy problems in the human ecosystem.

The reason for bothering you with these two models -- both of which are extremely simplified from reality -- is to make the following suggestion: The prodigious, phenomenal developments of technology have largely come about by the application of the analytic sciences, accompanied by increasing specialization. This has diminished communication among scientists generally and among the social sciences. I think we have reached the point where the emphasis must now begin to be placed on the sciences which synthesize as distinct from those which are essentially analytic. And here I think we have a message not only for the Department of Agriculture but for all phases of technology in a modern society. It is time, in other words, to turn attention toward the integrative synthesizing ecological types of sciences where one deals not with things and processes, not with simple linkages, but with the context of linkages within an entirely incomprehensible network of linkages. We can't work with all of it, but you can't work effectively without recognition of all of the collateral bleed-off.

Instead of going down the line of complete specialization and atypical tunnel vision, I think we should get upon the apex and try to look around at the entire system and try to relate every operation which we are engaged in to the relevant aspects of the total ecological system. Thank you.

DR. UPCHURCH: Thank you, Dr. Cain.

Dr. C. L. McCabe, Deputy Assistant Secretary, Department of Commerce. I hope you have caught your breath by now, Dr. McCabe. The podium is yours.

DR. McCABE: Thank you. I should like to compliment you on a couple of matters. First of all, for the choice of the topic. I think it is a very important one. But for me it was a traumatic experience because of the fact that you have allowed all of us 3 minutes. It is an extremely broad topic. I used to be a professor, and I prided myself on being able to take complex situations and boil them down to the essence, but I never had to do it in 3 minutes.

I found if I took this broad subject and generalized down to 3 minutes, I came up with nothing but trite expressions. I gave up on that particular tack and decided that the best thing I could do would be to make some offhand remarks about the general subject, taken from my own experience.

My remarks are divided into three parts -- first the character of advancing technology, or one characteristic of advancing technology, and then the economic effects and cultural effects.

One of the things that struck me recently concerning the character of advancing technology is that, more and more, we run into situations where technology is advancing in tremendous steps, steps involving very large expenditures of money and planning out into areas in which we have little or no data on which to operate. I cite the supersonic transport and high-speed ground transportation as examples, where even the resources of the very largest corporations in the country cannot make a commitment for the totality of the project. Therefore it is essential for a larger organization -- in this case the Federal Government -- to do the financing.

But one of the points that I think is extremely important when we run into these large projects, and when we have the Federal Government making tremendous commitments in the field is that we don't go so far off the beam because of the fact that we don't have the test of the marketplace. Typically, where we have the development of a product, where we take smaller steps and we can test each step in the marketplace -- whether or not this is really what people want and need -- we can build up a system which indeed people are satisfied with, and I cite the automobile as a case. When we get into very large acceptance of new ways, absolutely new ways of doing things with the latest technology, and we don't test the marketplace, we are apt to get off the beam. I think we always need to bear this in mind in our planning.

Secondly, a comment on economic effects of advancing technology. Obviously there are oodles and oodles of examples where advancing technology has greatly benefitted the economy and changed it drastically. One of the points that I think is important with regard to the effect of advancing technology on the economy is that, with advancing technology, we have plants and processes and products becoming obsolete all the time. This allows us, with proper planning, to bring about maximum change and innovation in our society and in our economy. The point is that advancing technology makes things obsolete, which gives us a tremendous opportunity for change and change for the good if we do good planning.

The third point concerns the cultural impact of advancing technology. To my way of thinking, the greatest opportunity and the greatest impact of advancing technology on our cultural life lies in the provision of more leisure time. We need to do more planning in this particular area, more planning along the lines of encouraging individual members of our society to use this time for creative activity. I am thinking particularly of the arts. There are tremendous opportunities here and we would be missing a good bet if we did not somehow or other, both in the private sector and in the public sector, give support and encouragement to individual creative activity on the part of our individual citizens. Thank you, gentlemen.

DR. UPCHURCH: Thank you, Mr. McCabe, and thank each of you for being here. According to my watch, we have about 5 minutes for audience participation now. I recognize the first question.

DR. BROWN: I was quite impressed by Dr. Ruttan's remarks. It so happens I am inclined to think that he is right. And I am just wondering, as agriculture has become more and more like an industry, has become more and more highly industrialized, to what extent have the private companies or the private corporations involved with agricultural production themselves become involved with research? If you look at the total R&D expenditures in the States, private industry picks up a fairly substantial proportion of the total tab. Are the large agricultural corporations beginning to assume their share of the tab, or do they leave it all up to the State and Federal Governments?

Then if I might make one more comment: In connection with the cultural impact of advancing technology, as a person who is not involved in agriculture except at the receiving end, I would like to make a plea, and that is that now that we have all sorts of problems licked by a proper use of insecticides and pesticides of various sorts and plant genetics. I am terribly impressed that we can breed a pineapple shaped like a can and things like that. But I would make a plea that we start breeding for taste again. This is a problem that hits me all the time. I remember boyhood flavors -- apples and things like that. Then I think maybe that is a false memory. And then by golly I go to the USSR and the apples are delicious--ratty, knotty little things--but perfectly delicious. I am wondering if you people in your agricultural research pay much attention to these less economic aspects of the problem.

DR. UPCHURCH: You have asked two very broad questions. Vernon, do you want to respond to the first?

DR. RUTTAN: I think that the question about the role of agricultural research in the private sector is a very important issue. I wish it had received more attention at this conference. I think firms engaged in farming are not doing much research but the farm supply industry is. This research does sharply change the task orientation approach at our universities. The clientele of the geneticists in our universities are the plant lead breeders in the corn-producing companies rather than the farmer directly. The rise of applied research in sectors related to agriculture does permit us to move back to a disciplinary orientation to a greater extent now than was possible in the past.

DR. UPCHURCH: Let me elaborate on this. Of course, the input manufacturing business, the farm machinery business, the fertilizer business, the seed business and many others do do a rather substantial amount of research that complements and to some extent contributes to our total output production capacity. The marketing firms do a lot of research. All of this, of course, is oriented to their own particular products and to their own advantage. We do have some estimates of the amounts spent for research by private companies. Dr. Maclay can probably give us the total amount.

DR. MACLAY: We estimate $400 million a year, which is just about the same as the State and Department research.

DR. UPCHURCH: On your second question, I think this particular panel had better just pass that question.

DR. BRADY: I am sure Dr. Ruttan didn't mean to leave the impression that there is any direct relationship between the number of

producers and the importance and need for agricultural research.

DR. RUTTAN: No.

DR. BRADY: Sometimes the number of farmers is equated with the need. I think this is absolutely absurd -- whether it is done by industry or the public agencies. The research need is probably going to be greater.

Also, the concept that once you do research, once you do this plant breeding and come up with a given variety, you are finished and can move on to something else. Nature doesn't let us do this. When we get up to a plateau, it is always trying to pull us down. There is a certain amount or research, probably more, that must be done as we move into the highly specialized farming with large farms. People research will still be there with us. I think we must not confuse the need for research with the number of active producers of farm commodities.

DR. UPCHURCH: A good point. I quite agree. To avoid infringing on the time of the other panel, I will accept Ted Byerly's question and that will end it.

DR. BYERLY: I want to be sure that I understood Dr. Ruttan correctly. I understood him to say that in the future there would be 50 to 100 thousand farms.

DR. RUTTAN: I say we can envisage this kind of a situation.

DR. BYERLY: Just your words. Are you predicting or projecting?

DR. RUTTAN: Here is what I am saying. We should move to that point as fast as possible. And if we move to a system that is characterized by the largest production units we have now, we would be there.

DR. BYERLY: I want to be sure you said it.

DR. RUTTAN: I said that the people who produce agriculture products will be better off when we get there.

DR. BYERLY: Two observations. If I recall correctly, the last year the net farm income was estimated at about $14 billion. Is that correct?

DR. UPCHURCH: A little over that.

DR. BYERLY: Twenty percent was perquisite, about $3 billion. There are in rural America about 10 million families. At $1,000 per family perquisite, non-cash income, including the $3 billion on the farm, you then have $11 billion cash farm income, and $10 billion non-perquisite income -- perquisite income living on farms -- the same amount. Economists have ignored this in their research for years. I want to know why.

DR. RUTTAN: No. There are two times when agriculture participates fully in what society has to offer. One is when there is no differentiation of function. The priest or his wives grow the agricultural product. The soldier grows his own food or his wives do. And the other time is when we move to the point where we are just on the verge of reaching now. I am disturbed that we see this and we are pulling back from it and we are trying to stop it from happening. I think we would be better off if, instead of trying to stop it from happening, we moved as rapidly as we could to the kind of agriculture that is possible.

DR. UPCHURCH: Gentlemen, I am impressed more by the unanswered questions than I am by the ones that have been answered here this morning. I am impressed more by the unsaid things than I am by what has been said. With all due respect and my thanks to the panel, our time is up. Mr. Chairman, I will turn it back to you.

DR. NORMAN: Thank you, Dr. Upchurch, and the panel, for your cooperation in the program.

We will now go to the fourth topic, the third listed in the program -- the panel on processing, distribution, and use of products of the land -- food and nutrition. Dr. George Irving will be the moderator of this panel. Looking at George's youthful appearance, it is hard to believe what I heard, that he started his career with the Department of Agriculture in 1928 -- almost forty years ago. He has been much involved in utilization research in the Department and became administrator of the Agricultural Research Service early last year.

Dr. Irving, will you take over?

PANEL ON PROCESSING, DISTRIBUTION, AND USE OF PRODUCTS OF THE LAND -- FOOD AND NUTRITION

DR. IRVING: Will the Panel take their battle stations up here at the table, Messrs. Brady, Bethel, Dunham, and Voris.

Your program identifies the members of this panel, with one exception. Dr. Dempsey, of the Department of Health, Education and Welfare, was unable to be here. So we Shanghai-ed Nyle Brady to take his place.

This panel concerns itself with the research areas of processing, marketing, and human nutrition. They are identified as the categories three, four and five of the material that Dr. Browning talked to us about this morning. Or if you prefer, in the folder that Dr. Maclay discussed, they are items 14 to 24 inclusive under tab 7. This area of research comprises about 20 percent of the total we are talking about in the sections in this symposium. This contrasts to about 75 percent in the area which Dr. Byerly's panel addressed itself earlier today.

We had asked the panel, prior to this symposium, to consider the material that they had at hand, which was not all of the material that you have had today. But to concern themselves with the relative importance of this unit of work to the total amount represented by processing, marketing, and human nutrition; the relative importance of this to all the rest of the research that is going on in agricultural science; and to take the individual items within the areas of processing, marketing, and human nutrition, and if possible indicate relative areas and relative emphases that should be placed upon these component parts.

So without further ado, we are going to ask the panel, beginning with Dr. Brady, to address

themselves to this question: Why should we do any public research in the areas of marketing, processing, human nutrition? If we should, do you think that the emphasis that is now being given it, as represented by the ratio of 75 to 20, is about right? And do you think that the relative degrees of emphasis given to marketing, processing, and human nutrition of the Department, which are as 11 is to 7 is to 2, is about right? I have said my say. It is up to the panel. Dr. Brady first.

DR. BRADY: Gentlemen, and Dorothy. George has already double-crossed me. The one thing he said was that if I took this assignment he would sure put me on last so that I could only take the last 2 minutes. The other thing he said that should have disturbed me a little more when I pointed out to him that I knew nothing about this subject, he said he didn't see why that should bother me, that I had a job in the Department of Agriculture for 2 years and didn't know anything about the subject and it didn't seem to bother me.

I would like to make one comment with respect to this kind of research that has been discussed already. There had been a little bit of a feeling that unless work is done by a social scientist, or an economist, it is not people-oriented. I would like to submit that the work we are talking about here in marketing and processing, utilization of farm products, is people-oriented and not necessarily farm-oriented, but oriented toward everyone who uses food and fiber.

I would further like to say that even if we use a more restrictive definition of people-oriented research and move down to the social sciences -- and I don't believe there is anyone that I worked with that fought any harder to get more support for social science in the Department of Agriculture than I did -- even if we use this more restricted definition, agriculture still shines better than the rest of the country in relation to the proportion of their effort that they put into the social sciences.

I think you will find a figure of about no more than 4 percent of the total R and D in the country as a whole going into the social sciences. It is more than twice that amount in the Department of Agriculture. But may I repeat: I feel that we should have a higher proportion of our effect moving in this direction. But not, as we pointed out to the Secretary yesterday, by cutting out the effort going into other areas.

It would take a long time to make a good economist, or even a poor economist, out of an agronomist or out of a plant pathologist, just because during a given period of time we suddenly want to change our direction. I think these directions have to be changed over a period of time. You can not turn on and turn off research work at the whim of a budget maker.

I am convinced that the utilization and marketing research is not going to provide and has not provided the panacea that most of its supporters thought it was going to provide. I think the Congress, in providing funds for utilization research, did so under the impression that if we just knew how to use these farm products better, that this would automatically keep us in the marketplace -- automatically make it possible for us to outcompete other products, and I think this has not been true completely. With all the marketing we have put too much funds into producing farm products and not enough funds into how we market them, how we get them on the marketplace in an acceptable manner.

On the other hand, another of the reasons for this is the fact that we are competing with each other, that the work at one laboratory is providing through its utilization work products that compete with the products that come out of another laboratory. I don't think this is all bad. All I'm trying to say is that this hasn't provided the panacea that they asked for.

On the other hand I can't help but feel that in the balance both the marketing and the utilization research has paid off. It seems to me that in the end this is the way that you judge whether research work should be done and the absolute effort that goes into it.

I don't need to give the examples. You know them as well as I do. In spite of the fact that I have a Dectolene [2] shirt on this morning, I am more apt to wear a cotton shirt than I would be if the utilization laboratory at New Orleans didn't exist. And I don't wear these all the time. I have a combination, depending on which one my wife happens to buy. But I don't find cotton shirts much more to my liking than they used to be. If we didn't have that laboratory, this wouldn't happen. I have a wool shirt that had been treated with a process developed at the Western Utilization Laboratory that my wife can wash and not worry about its shrinking up. I think this is to the advantage of the consumer as well as to those who produce farm products.

We have seen new uses of products come from these laboratories, although there is considerable argument as to the figures that have been used to justify the research work. I think the reference that has been made here, to penicillin, to frozen concentrates, I don't know whether reference has been made to some of the paints, use of farm products in paints that are about to be pushed out of the market through the utilization laboratories, have been put back in. I don't think there is any question but what if you add all these up on a cold, hard, economic basis, you would find that as far as the consumers are concerned, as well as the farmers, that these have paid off.

As we look into the foreign aspects of our program, as we are beginning to wake up to the fact that, probably next to peace, this food and population business is our most serious world problem and it is in our lap as the most

[2] Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture over other products not mentioned.

serious problem we have in this country. Utilization laboratories, marketing research, getting these products from the farm into the hands of the people in such a way that they are nutritious, in such a way that they will provide and continue human life -- all such work at the utilization laboratories and the marketing research is absolutely essential in order to do this.

I do have some very serious reservations, however, both in the utilization and marketing research as to the organization and the way that this is carried out, in that I am frequently in the minority in working with my compatriots in some of the land grant institutions. I think that it is not in the best interest for every experiment station in the United States to have a certain proportion of its funds earmarked for marketing research. A few of the stations that have either a big enough program or big enough problem to where they could really go into this as it should be gone into, and do the work for a whole region, in cooperation with the Department of Agriculture -- to me this makes sense.

But to have every experiment station have to put in so much, a certain proportion of their research moneys, into this area, and in some cases necessarily having a shoestring operation doesn't make sense to me.

Similarly, I think there should be utilization research work done in universities, at least the underpinning, basic research which is related to this. But again I think it would be a serious mistake to have funds allocated in such a way that every experiment station in the United States had to use a certain proportion of their funds to carry out the utilization research.

I think that the success of this program, the program of the Department of Agriculture in utilization, has been dependent upon the fact that someone, for whatever reason, political or otherwise, decided that they would build large enough physical units to where you could have a team of scientists approaching these problems, and not scientists scattered throughout the country, or through a group of very small laboratories.

I would say that the current level of support in these areas is appropriate. I do not believe, however, that it is organized, especially because of the requirements placed on the land grant universities, in such a way that we are getting most effective use out of them.

You say how could this be handled. I think there are all kinds of ways and still not break Lou [Upchurch] with this concept of getting distribution of these funds out on some sort of an equitable basis, on a formula basis if you will, but not on a basis that says everyone has to do this research in order to get the funds that are involved.

Thank you.

DR. IRVING: Thank you, Nyle, Director of Agricultural Research, Cornell University. I forgot to identify you.

We will get primarily the forestry view from Dean Bethel, Dean of the College of Forestry, University of Washington.

DR. BETHEL: Thank you very much.

You will detect, I think, quickly that I am probably not going to stay with the assignment. You will also detect I think that part of the reason for this is that I have rather strong feelings which I have expressed to some of the folks in the room that you really can't take a research program designed around what seems to me the classical fields of agriculture and stuff forestry and natural resources into it and have it come out in any sensible way.

Having been a member of the staff of three land grant institutions and in my current position at the University of Washington being a cooperator with the Department of Agriculture -- both CSRS and the Forestry Service -- I am very much interested in the direction that forestry research takes within the Department. And so the things that I say are, I hope, for the purpose of being helpful and useful as you proceed with this 10-year program.

I think it is important that one look at forestry research in the broad aspect, and also in terms of the Department of Agriculture's concern for forestry research, in terms of the history and traditions of forestry and forestry research in the United States. They are indeed different from the history and traditions associated with the other areas of agriculture.

Our research problems stem from some of the same sources as the problems that have been discussed in considerable detail for the last two days. We are faced with a situation in which we have a limited resource, forestry land or wild land, subject to a continually increasing demand that results from an increasing population.

You have heard a lot about the population pressure with respect to the need for food. It is also important with respect to the need for forest products of all kinds. With respect to the products themselves, we are concerned with the commodities that come from the forest, the lumber products, pulp, plywood, panel products, and a whole variety of other things that make up the forest products spectrum. We are also concerned very much with the sort of services, social services, that are related to the use of forests, and these are very real products and have been alluded to this morning. Increasingly, the need for the use of forests for recreation, for wildlife, game hunting, fishing, camping, hiking, mountain climbing -- are important. It is in this area perhaps more than any other that research is deficient.

I spent 2 days last week, very interesting and sometimes a frustrating 2 days, attending a session of the Senate Interior Committee concerning itself with the recently presented study report on the North Cascades. This was done jointly under the aegis of the Secretaries of Agriculture and Interior.

Commenting on the issues that were involved here, I think that the one thing that was clearly evident and came out of this report and also the comments that were made by almost 300 witnesses that appeared before the Committee -- one thing that was not mentioned at all in the report I might say, and not mentioned by but a small fraction of the people who commented before the Committee, was the fact that there was essentially no base of information coming out of research upon which to make judgments people were being asked to make. There is a complete vacuum in research in this area, I suggest. And, as a result, what you have filling the vacuum is a very great deal of emotion.

So in the forest products research we need to be concerned in the future not only with the commodity products of the forest; we need to do a great deal more research related to the social uses of the forest. This gets at some of the questions that have been raised with respect to other areas of agriculture in terms of the need to get the social scientists more involved.

I would like to comment also on the institutional arrangements that are available for the conduct of forestry research, and some of the ways in which they differ from the institutions and institutional arrangements that are available in other areas of agriculture.

There is a somewhat different basis for conducting, for example, utilization research in the area of forestry than perhaps is common to the rest of agriculture. The Federal Government and the State governments are themselves not only the producers of research and the sponsors of research, but they are also in very large measure the users of research in the area of forestry, because they own and operate and manage large forestry properties. So that one can argue for the conduct of research and the sponsorship of research by the Federal and State governments and forestry, not only for the general good but also, because in the process of managing the properties over which they have custodianship, they need this research.

The pattern of forestry education and of universities involved in forestry is also quite different from that which has been traditional in the other areas of agriculture. I think it is important to note this and to understand in what way it is different.

First of all we don't have what constitutes essentially a fixed number of institutions operating in the area of forestry. The land-grant institutions have for a long time been involved in forestry, many of them at least. But forestry also has been an important part of the educational complex, an educational pattern in a good many universities that are not land grant institutions.

Some of the oldest schools in the country and some of the biggest producers of doctorates in the field of forestry are institutions that are neither State-sponsored universities nor land-grant institutions. Duke and Yale are good examples of schools that have been heavily involved in this area. The Harvard Forest at Harvard has been a significant factor in forestry research over the years. In addition to these private institutions there are a number of State universities that are not land-grant institutions with long traditions in forestry -- important producers of doctorates in forestry who go on to do the research in the universities and in the government laboratories. Here, I would refer particularly to the University of Michigan at Ann Arbor, to the New York State College of Forestry at Syracuse, part of the State University of New York system, to my own college of forestry at the University of Washington, and others in this category.

Then there are institutions that are State supported and neither State universities nor land-grant colleges that are involved in forestry. We see a great many more of these appearing on the horizon, schools like Humboldt State College in California, which has one of the largest enrollments in forestry in the United States, schools like Stephen Austin College in Texas. I can name a dozen others.

The numbers of schools and colleges and universities that are involved in forestry are increasing. We are accrediting in the American Society of Forestry this year two new institutions. Both happen to be land-grant institutions. There are 8 more on the threshhold of accreditation, asking to be considered in one way or another for accreditation, and of these 8 only 3 are State land-grant institutions. Some 20 other institutions that are teaching forestry and are coming along in this direction, and a relatively small number of those are State universities and land-grant institutions.

So in the long picture if one is going to use the total academic resources in forestry for research, whether you think it is a good thing for agricultural forestry to develop this way or not, one has to consider that the number of institutions is increasing, and that the mix of institutions in forestry is greatly different from that in agriculture generally, and that it is likely to change more in the direction of being different in the future than it has in the past.

I don't want to take more time than I should from the other members of the panel. But I would like to argue, I think, that as you develop a long range plan for agriculture, in the Department of Agriculture, and as you look at the direction in which forestry research is going, that you consider forestry research, its future development, and the role that the Department of Agriculture as a public agency has in that development within the context of the history and tradition of forestry as contrasted with some of the other fields of agriculture which, I might say are far ahead of us in many respects.

One final note. I think that the greatest deficiency that we have in forestry today with respect to research is perhaps not the laboratories but people. There is a terrific shortage

of competent people to do good forestry research. And in any research program that is to be meaningful, it seems to me it must have as one of its goals that of increasing the supply of competent people who can do research in forestry. I think I would be much happier if I could see on the list of goals for your 10-year plan one that said that it is the goal of the Department of Agriculture research program to increase the number of people that are competent to do agricultural research. If you don't need them in the other fields, we will use them in forestry. I am not talking here entirely about people trained in schools and colleges of forestry. To paraphrase some things that Roger Ravel said in the past, I think forestry is too important to leave entirely to the foresters. We need the kinds of talents that come out of the departments of botany, zoology, chemistry, physics, and engineering. Thank you.

DR. IRVING: Thank you, Dr. Bethel.

The Atomic Energy Commission's Division of Biology and Medicine has things in common with the Department of Agriculture. Let's hear from the Director of that Division, Dr. Dunham.

DR. DUNHAM: I will confess at the beginning, too, that I am going to deviate somewhat from the topics that were laid out for the members of the panel, partly because of my ignorance of many of the things that I am supposed to be discussing. I do have some reflections that might be helpful to some of you in your thinking.

As I sat here for a day and a half of this very educational meeting, I was very much impressed with Dr. Byerly's comment that research is no better than the people who do it. And I think agriculture can be proud of many of the researchers which it supports. After all, there is Sterling Hendricks who I think is without peer in the scientific world. Lush is a great geneticist. Overstreet is a great soil scientist. They are all part of your general program of research, and those of us who have had to deal with them have found it a real pleasure and stimulus.

I think, however, that Dr. Brady has mentioned a point which has come home to me from time to time as I visited around the country, and that is the unevenness of some of the experiment stations, and the drive somehow to have somebody at each experiment station who is a specialist in every little "bitty" subfield of agricultural sciences.

State boundaries were drawn, many of them, with State lines. They bear no reasonable relationship to watersheds in many cases, or farm practices, or crops. I think an effort to consolidate would certainly be in order. And I know that this effort is already underway with your, I think you call it, Pioneering Research laboratories.

In one of the groups that we deal most with, I have seen this tendency to diffuse, to have three or four people in poultry science, three or four people in this, that, or the other thing. Whereas, the experimental station could be famous throughout the country for a particular area or two areas or three areas as a whole, and let the people in the neighboring State experimental stations worry about something else. This may be completely beside the point and merely reflect my ignorance but it is something I have felt as I have moved around.

I sense both an undercurrent -- and there were some explicit statements made by Dean Price last night -- that there are certain elements in the Academy of Sciences who worry about the scientific stature or the prestige of the scientist in the agriculture program. This may be one way to look at this problem. Generally, the experimental stations, as I have seen them, reflect the State, and they reflect a great deal about the State -- the State's interest in science, the State's sophistication in science, and the State's standards in science.

There is another thing I think that is worrying the Academy people, rightly or wrongly, and that is that somehow agriculture is not in the swing of basic science, basic research, though God knows nobody is more fundamental in his outlook on research than Sterling Hendricks. And I think it possibly isn't as much that, though this is what you people say. It is a feeling that somehow agriculture is taking away something and not giving anything back to the educational system.

We sensed this in our own program a few years ago. We were taking plant scientists for some of our experimental work in plant radiobiology. We took a look around the country at what we were doing and we found we were actually taking people out of the educational system and taking them to our laboratories, to our field ecology projects and the like, and putting no input back except at the post-doctoral level. This led to the project which we have just started at Michigan State, where we are trying to set up a strong program scientifically and by which we hope to proselyte people into the plant sciences. So we are making a contribution to new people coming along who will be available not just to AEC's programs but to everybody's.

There is another element in this and I hate to mention it, but I think it is a real one because I run into it in my own shop. It is a certain intellectual arrogance among the laboratory scientists when they look at a person who works in the field. We have a small program, all of which are field studies. It is awfully hard to get well-disciplined scientists to work in the field; conditions are a lot more difficult to control than in the laboratory. Yet it is the laboratory scientist who turns up his nose at the people who try in many ways to accomplish what is a much tougher job -- that is, doing studies in the field, working with a whole host of variables which cannot be controlled but can be studied and valued if the group is enthusiastic and diligent enough.

I would like to say just a word on promotional activities, because that is really what

marketing is. I think AEC has been fortunate in that practically everything it has promoted has been in competition with some already existing activity -- whether it is the coal industry or the oil industry from the standpoint of nuclear reactors, whether it is ordinary food processing if it comes to radiation food preservation. The Joint Committee encourages it, directs that the Commission get into this. The Appropriations Committee looks at it from the other standpoint and says, Is this necessary? Isn't the present system good enough? Who are you going to put out of business?

I will touch very briefly on the problem of insecticides, pesticides, and contamination of foods because I think we have had a bit of experience in our own problems with radiation and in the developing radiation and biology program which is developed around this. I urge the Department to see that its program in this area is extremely strong, not only from the standpoint of laboratory studies but also field studies. Because if it isn't strong and other agencies and other interests become more sophisticated than the Department in this area, agriculture will suffer. There is no question about it. From the standpoint of the world problem we are going to have to use every kind of gimmick to increase production, and it will probably involve pesticides, fungicides, and what-not to do this. I think agriculture should bear the responsibility, and gladly so, for developing knowledge and how to cope with this particular type of contamination.

Finally, our Chairman asked me to say half a word on nutrition. I was impressed with Phil Handler, who is a purist, sort of suggesting that we knew within a factor of 2 pretty much what the requirement for calcium was in a number of other foods. I submit that to add decimal points beyond this is not worthwhile, simply because human variation is very great. Furthermore, as Phil pointed out, malnutrition leads to parasitic infection, but also parasitic infestations change the nutritional requirement tremendously. So I think there is need for a lot of research in nutrition, highly specific, but not on the broad problem of how much the average American needs of calcium, this, that, or the other thing. I think we are close enough, and people's habits could never be controlled precisely enough so that getting any better than a factor of 2 I think is hardly worthwhile. Thank you.

DR. IRVING: Thank you, Dr. Dunham.

Our anchor man is Dr. Voris, Executive Secretary, Food and Nutrition Board, National Academy of Sciences, National Research Council.

Since the others confined themselves to three minutes, I'm sure you won't break the set.

DR. VORIS: Dr. Dunham has introduced the subject of nutrition. I assume that that is what I am left to talk about. So three minutes is plenty.

I was disappointed that Dr. Bethel didn't include among his research and forest products the isolation of enzymes from termites so that they could be adapted to humans, and people could learn to eat paper.

The science of nutrition falls into this cycle which Dr. Cain has put up here. Of course when it comes to humans, it extends over into this other pattern (indicating). So it is a subject of ecological interest.

I would like to make a distinction first between what we know in agriculture as animal nutrition and compare that with the different problems that occur in human nutrition.

Every biological organism is endowed with a genetic and somewhat conditioned pattern of nutrition, so that every individual of every species has to be considered independently, although there is uniformity among our domestic animals that we have domesticated for food purposes. There has been great use made of the science of nutrition, and the Department of Agriculture and the land-grant colleges have furnished much of the basic information in terms of nutrient requirements for animals. This information, as it comes into existence, has been synthesized through the Committee on National Nutrition in the Academy into a pattern for each type of domestic animal that we use in our food. I think this again comes back to Dr. Cain's point that we need this synthetic approach after the research results are available. We need to synthesize them into a pattern in which they become applicable. This has been reasonably well done in terms of animal nutrition.

In terms of human nutrition you have a completely different breed of cats. While again for every human organism a nutritional pattern will be genetically determined, in the human species we have become widely conditioned to a variety of foods and recipes with color, taste, and palatability which, unlike the feeding of animals, we don't conglomerate it into a formulation, mash or mix. So the determination of what constitutes human nutrition involved first the science of nutrition in determining approximately what the pattern of nutrient requirements are for healthful nutrition. Secondly, a relation of this matter of requirements to what is available in the food supply. Here, the Department of Agriculture has done very well in its development of tables of composition of foods which are used with the recommended dietary allowances and can be used to determine the per capita availability of the various energy and vitamin nutrients. Every 10 years or so there is a very grandiose survey made of the family of food consumption and what people are eating.

This, related to the long range pattern of agricultural research as it relates to food and nutrition, is where the Agricultural Board has a major contribution to make. It is assigned the responsibility for the nutritional welfare of all of our citizens. It is the pattern of establishing standards of nutrient intake to recommended allowances and the calculations that come about, whether these allowances are available for everybody in the United States.

That leads into the question, then, of the distribution either regional-wise, family-wise, or individual-wise. But the ultimate result of nutrition is what the individual is or becomes from what he eats. Here, there comes a question as to how far the Department of Agriculture should enter into the determination of the state of health of this individual as a result of the nutritional qualities and products which the Department has so aptly produced.

Among the human race the prerogative for evaluating the healthful status of nutrition is largely the prerogative of the medical profession. If research in human nutrition and metabolism is to be in the Department of Agriculture without the consent and counsel or participation of the medical profession, it loses its effect. It becomes information to the individuals that have done the research, but it doesn't get out where it has application in the medical and behavioral segment of the population.

So my suggestion in terms of the planned long-range program in human nutrition is that insofar as you can, the Department of Agriculture should give thought to how it can either share its responsibility in terms of the healthful end of nutrition with the health or medical profession rather than trying to do it in its own shop where it can be done possibly just as competently but does not reach the objective which is the evaluation of nutrition, USA.

In relation to this point I might cite this publication of the California experiment station, Nutritional Status, USA, which contains a reference to 150-odd publications, which were published either in experimental station bulletins, various journals or what-not. It may be all good research, but the only synthesis in interpretation of the new nutrition USA was in this experiment station bulletin. There were about a thousand copies available. This is the last one I can locate anywhere. But it has been completely ineffective other than to the people who actually did the research or had the publications. It has been ineffective in terms of public health and nutrition in the United States.

There is no center in the United States where the nutritional welfare of people can be determined. We have no bureau of vital statistics in human nutrition. I think that the Department of Agriculture can take leadership either within its own activity or finding some way of developing this collaboration and cooperation of the people in HEW, the Children's Bureau, and a few of the others. There are focal points here where the material you develop, which is very variable, can be put into the total program for Public Health and Welfare.

DR. IRVING: Thank you, Roy. I appreciate, gentlemen of the panel, your contributions, which are certainly pertinent to the subject matter of this symposium. It is nice that some of them are even pertinent to the subject matter of our panel. Thank you.

DR. NORMAN: On your behalf may I thank the various participants in the morning program. I apologize to you as Chairman that I did not have it within my power to provide some extra time for the interesting discussion which would have developed had we not perhaps filled the morning a little too tightly in the program. The plan is to reconvene at 1:15.

(Whereupon, at 12:32 p.m., the Symposium was recessed to reconvene at 1:15 p.m. the same day.)

AFTERNOON SESSION
(1:15 o'clock p.m.)

DR. UPCHURCH: Gentlemen, this has been a long day-and-a-half session, full of many interesting ideas. I think the best is saved for the last.

I am your substitute chairman for the afternoon. Dr. Koffsky was scheduled to be chairman of your afternoon session. A flu bug and his doctor dictated otherwise. So please bear with me as your substitute chairman.

This afternoon's session, I think, will be particularly interesting. I was a bit amazed at the beginning of our session yesterday morning to find that the world food problems came quickly into our discussion. This afternoon's session will be devoted more directly to that general area of problems and ideas, and we have as our leadoff a most distinguished person in the person of Mrs. Dorothy Jacobson, Assistant Secretary of Agriculture for International Affairs.

Mrs. Jacobson is a native of Minnesota, from the University of Minnesota, was administrative assistant to Mr. Freeman when he was Governor of the State. Mr. Freeman brought Mrs. Jacobson into the Department of Agriculture when he became Secretary. Those of us old-time professionals in the Department who have had occasion to work with Mrs. Jacobson over the last 4 years have come to have an increasing appreciation for her as a person and for her professional intelligence and integrity.

It gives me great pleasure to present to you Assistant Secretary Dorothy Jacobson, who will talk to us on the subject "Opportunities to Aid Developing Countries."

Mrs. Jacobson.

OUR MISSIONS ABROAD -- OPPORTUNITIES TO AID DEVELOPING COUNTRIES

By Mrs. Dorothy H. Jacobson, Assistant Secretary of Agriculture

MRS. JACOBSON: Mr. Chairman and gentlemen:

As usual, on an occasion of this kind, I learn much more than I can contribute. You have been discussing "Research in Agriculture" -- and in that context I have been asked to discuss "Opportunities to Aid Developing Countries."

The Administration has just presented to the Congress a new program for food aid to developing countries. In formulating that program we were impressed with both the importance and the limitations of research in this field.

About a year ago we started to consider the kind of food aid program that ought to prevail in the United States at the time when Public Law 480 was scheduled to expire at the end of this year. We started, within the various agencies of government, to discuss this problem in terms of the food needs and food resources of the world, and in terms of the American productive capacity.

Our time schedule was limited, but we tried to make use of whatever help was available. We looked forward to the appearance of one survey of research on the effectiveness of our food aid policies. But when it appeared last September, we found that -- as its editor had noted on the first page -- it was not very useful.

We recognized problems we had experienced in trying to use scientific methods to evaluate our programs. Some time ago, for example, we sought to ascertain how much improvement in the health of school children could be expected from school lunch programs we were providing. It was generally believed that a nutritious school lunch was good for the children, but we had no scientific study to prove it.

It was decided to make such a study in connection with one school lunch project. Some time later we were faced with complaints that this project was being held up because of requirements that had been established in order to evaluate the program. All of the children were to be weighed, measured, and examined. Later, those receiving the school lunches were to be compared with a control group. But the particular underdeveloped country in which the program was scheduled had not been able to set up the program for weighing, measuring, and examining these children, and therefore this school lunch program was being delayed.

Thus we were faced with the question of whether to hold up the feeding of these hungry children until we could get a scientific study as to how much good it was going to do.

In making such decisions we have to determine priorities for various kinds of effort. We have to consider conditions that prevail and the degree of urgency involved.

It was necessary for us to plan a food aid program to submit to the Congress before we had enough research in physical and behavioral sciences to answer all of the important and relevant questions.

We did, however, make use of the best knowledge that we had. We studied what the problems were likely to be in the years immediately ahead.

We are presenting a new program in food aid primarily because of two conditions, one relating to the United States, and the other to the world.

Our commodity farm programs, in the past few years, have had enough success so that surplus stocks of many of our agricultural commodities are dwindling. Therefore a food aid program for the years ahead cannot be based on the surplus concept. This is, in brief, the new situation in the United States.

As for the new condition in the world, we face what many call a population explosion. Demographers have been aware of it for some time. But it has received public attention only recently.

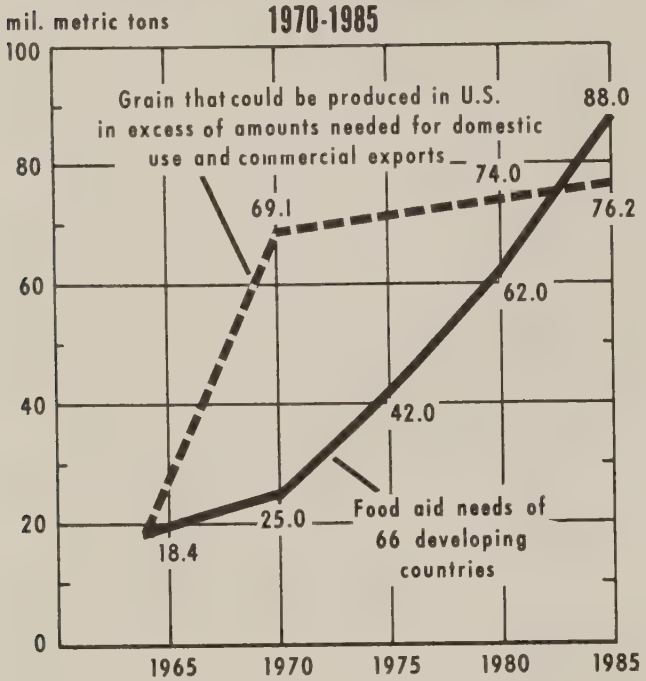
The "population explosion" results primarily from an amazingly sharp drop in death rates during the past few years.

I am told that the death rate in Ceylon dropped 40 percent in one year because of the use of DDT. I was told by a representative of the Indian Government that one million more people survive in India each year because of their success in combatting malaria.

Millions of lives, that are now being saved as a result of scientific advance and public health measures, are now threatened with hunger and malnutrition.

A year or so ago we began to see black headlines forecasting a "collision course" in the race between population and food supply. We looked at this in terms of its implications for our food aid program. We come up with what is shown rather crudely on this chart.

U.S. Availability of all Grain for Food Aid and Food Aid Needs of 66 Developing Nations, 1970-1985



The solid black line projects needs for food over and above what 66 aid-recipient countries can produce under present rates of agricultural growth. It is drawn on the assumption that their own food production will increase only at the rate that prevailed in the recent past, which is about 2.6 percent a year, about the same as their average population increase.

It is drawn on the further assumption that the population will increase in these 66 countries at the rate of the U.N. medium projections.

It is drawn under one further assumption, that the per capita consumption of food in these countries will increase slightly, over the years, due to slightly rising incomes, and due also to the fact that we could not accept a situation projected into the future at which their food consumption would increase no faster than it has in the past recent years.

These aid-recipient countries now have diets that average some 10 percent below minimum caloric standards.

They have been increasing these inadequate diets at the rate of only a third of a percent a year. At this rate it would take 30 years to come up to a minimum standard of caloric intake. That is unacceptable. It is unacceptable to them for obvious reasons. It is morally unacceptable to us.

And so we assumed a rate of increase in their consumption, on the average, that was both acceptable and within reach. We assumed sufficient improvement so that, by the year 1975, in roughly 10 years, the average per capita diet would equal minimum standards essential for health.

At that rate, assuming their production to grow as it has, assuming this very slight increase in per capita diets, this solid line measures the increasing needs for extra food over and above that which they can produce. It is indicated as million metric tons of grain.

Last year we provided a little over 18 million metric tons to these aid-recipient countries. By 1970 that 18 million deficit would rise to 25 million. By 1975, to roughly 42 million, and in another 5 years to 62 million.

The broken line was projected to represent production that we would expect in the United States if we ended current farm programs and allowed diverted wheat and feed grain acres to return to production, under current price levels and expected yields. The figures indicate amounts that would be produced over and above our domestic needs and expected commercial exports.

Between 1965 and 1970 we would expect a sharp increase as a result of bringing diverted acres back into production. By 1970 they would probably all be back. By 1970 we would produce 69 million tons in excess of what were needed for domestic use and commercial export. As you can see, this is 41 million tons more that could be used for food aid. This is, in other words, a 41-million ton surplus. By 1975, when the needs of these countries would be up to 42 million tons and our production up to about 70 million, we would have about 30 million tons of surplus annually.

By 1980 there is still a gap of 12 million tons annually, with the United States producing more than their projected needs.

But before 1985, these two lines would cross.

By that year, the hungry aid-recipient nations would need 12 million metric tons more than we could produce from all of our acres.

Whether our guesstimates are right as to population, as to the rate of per capita increase, and even as to the rate of yields, the point at which these lines are going to cross is coming, and it is coming in the relatively near future if present trends continue. This is the point at which, as President Johnson said in his food aid message, all the production from all the acres of all the agriculturally advanced nations in the world will not be able to provide enough food for the two-thirds of the world that is hungry -- unless the hungry world itself increases its own food production.

So the answer is very simple. There is only one answer to this collision course. It is to increase the agricultural productivity of the less developed countries.

Can such an increase in production be achieved?

Again, we have had a study that indicates the answer. Our Economic Research Service analyzed the agricultural production of 26 developing countries over a 15-year period, ending in 1963. Of these 26, twelve succeeded in improving their agricultural production more than 4 percent a year. The average of these 12 was over 5 percent a year. One -- Israel -- increased at a compound rate of over 9 percent a year.

A comparison was made as to factors that prevailed in these twelve countries that enabled them to accomplish so much more than the other fourteen. Is there any common denominator that seems to result in this kind of increase in agricultural productivity?

Some of them were tropical, and some were temperate. Some had high levels of literacy, relatively, and some very low. Less than half of them had new land that they could put under cultivation, but more than half had to do it by increasing yields.

Out of a variety of factors, there was only one factor that they all had in common: A sufficient national determination to improve their agricultural production, to give that effort priority, to adopt policies directed toward that end, whatever the varying policies that might have been called for in each particular circumstance.

This study gives us hope that increased agricultural production can be achieved in the hungry world. It will be very hard. It will be difficult because most of the developing countries don't have the characteristics that make for quick improvement of productivity. Yet twelve of the countries studied increased their agricultural production at a rate faster than has ever been achieved by the agriculturally advanced countries, including our own, for a similar period of time. Of course, they started from a lower base.

There is tremendous room for research; tremendous room for education; tremendous room for policy changes. Dr. Moseman will present what is being done much better than I could do.

I want to point out one more thing. I believe, and it has been expressed many times here at these meetings, that advance in the physical sciences has gone faster than in the social sciences.

There has always been a gap, I think, between these advances. There has always been a gap between what needs to be done and knowledge of how to do it best. But in the past periods of history, when change did not take place at such tremendous acceleration as it is taking place today, the need for closing that gap was not as urgent as it is today. Knowledge has progressed faster in physical fields than in the field of human relations. Partly, I think, because of the attention that has been given to it. But partly, I think, because in the field of human relations it is more difficult to find the right answers.

I believe there are several things in our favor. I think that government and those powers within and without the government that determine policy listen more carefully to the advice of the scientists and to the best product of modern knowledge than ever in the past.

Secretary Freeman said, in his testimony before the Housing Agriculture Committee in presenting our new Food for Freedom program, that there is another explosion taking place today that is perhaps more important, and certainly more hopeful, than the population explosion. That is the explosion in knowledge that is another characteristic of this generation.

This offers opportunities to find the answers. The food aid program that was presented to the Congress has been designed to meet today's problems in terms of the knowledge that we have today. It is based on a recognition that, while we will need to provide food aid in the years ahead, we must direct that food aid toward giving encouragement, help, and incentive to the developing countries, the hungry nations, to improve their own food production. It asserts that unless we do that -- if we use food aid only to feed hungry people -- we will actually contribute to the impending disaster that would occur when the world could no longer produce enough food for its people. The only way to forestall that disaster is to use our food aid only as a help to get over this critical period.

One of the comments that appears in the World Food Survey, 1970, which our Economic Research Service put out a year or so ago, expresses most succinctly the challenge we face. That comment is this: "The race is not so much one between population and food supply as it is between what could be done and what will be done."

What could be done has, in a large measure, been decided by the advance we have already seen in science and technology. What will be done depends pretty much on what policy we adopt in this country and what policies are adopted in the developing countries. It will depend upon the degree of understanding of the kind of programs that are needed on the part of the peasants in India and the farmers in Iowa. It will depend in part upon the kind of help that leaders like you can give to the understanding of the problem here in this country.

Thank you.

DR. UPCHURCH: Thank you, Madam Secretary, for this very interesting and informative introduction to the general question of our missions abroad.

I think I shall forego accepting any questions or discussions on this paper because we have scheduled later in the afternoon a period for a panel discussion.

I was told one time, a number of years ago, by an eminent after-dinner speaker, that the purpose of a chairman of a session was first to capture the attention of the audience, and secondly, to establish the excellence of the particular speaker of the time. On this particular occasion neither of those functions is necessary on my part. The attention of this audience is captured by the very subject matter that is involved, and the establishment of the expertise of the people participating here needs no elaboration from me.

Our next speaker on this panel is a man eminently qualified to talk to us about the subject assigned. I first knew Dr. Moseman when he was director of the Crops Research in the Agricultural Research Service. He, too, is a product of Minnesota in a sense by way of Nebraska -- originating in Nebraska -- with a doctorate degree from the University of Minnesota. In 1956 he became assistant director of agricultural programs for the Rockefeller Foundation and advanced to director in 1960. In 1965 he accepted the call from the Department of State to become the Assistant Director for the Agency for International Development. Without further introduction, Dr. Moseman is going to talk to us on the subject of science and technology in international agriculture.

Dr. Moseman.

SCIENCE AND TECHNOLOGY IN INTERNATIONAL AGRICULTURE

By A. H. Moseman, assistant director, Agency for International Development, Department of State

Sixteen years ago, from January through March of 1950, I was on a survey team that was sent out by the Department of State to review problems and opportunities in some of the developing countries that might be undertaken as technical assistance projects under the then pending Point IV activity. This was the first team that was sent out by the Department of State, and I think it is rather significant that it was an agricultural group. There were three of us: One from the Extension Service, one from the Foreign Agricultural Relations, and I was selected to represent the Research Service.

The team was sent to the Near East and Middle East countries and to South Asia. So while I was not really involved in the conceptual stage of the Point IV program, I was somewhat engaged in midwifery. I might say I didn't catch up with it again until it was in the teen-age stage, about 16 years later.

In India in 1950 the country was engaged in a "Grow More Food" campaign. Those of us from the United States were identified as people from a country where we were producing so much wheat and corn that we had to burn it. This did not make it particularly comfortable to visit some of the Indian villages, and yet we were quite impressed with the attitudes of some of the Indians we met. I remember particularly the Indian farmer in a village near New Delhi who, after our visit, insisted on being heard. Through an interpreter he pointed out that the Indian farmers are not lazy, they are not stupid. He said, "Give us better tools and better methods and we will produce as much as farmers anywhere."

Today, 16 years later, India is engaged in food rationing, facing food shortages, famine, and possible starvation of millions of its people. The monsoons again have been short in 1965, and the food grain deficit of the country is projected at various figures. The one that I think is presently accepted is a deficit of about 12 million metric tons, with a total production of 76 million metric tons.

The question India faces is whether this is an emergency or a chronic problem. In 1959 the Ford Foundation supported an agricultural production team that reviewed the capability and the needs of agriculture in India. The team projected that India would have to engage in an all-out agricultural production program if by 1965 and 1966 they were going to have adequate food supplies for a population that was estimated at that time at the level of 480 million.

They projected also that the food grain needs would be at the level of about 110 million metric tons. If we take a look at India's food grain production since 1959, we find that in 1960 India produced 78 million metric tons. The next 2 years it climbed to 80 million. In 1963 it was 82 million. In 1964 it jumped to 88 million. While we cannot say that the food production curve has leveled off, there is at least uncertainty as to the level of the incline. The population at the present time is increasing at the rate of 11 million people annually.

What have we done in cooperation to improve India's agricultural development in the period from 1950 to 1965? The emphasis in the early years of the Point IV program was on "the transfer of knowhow." We were misled by the success of the Marshall Plan, in which case we were rebuilding European industrial economies that had a strong base of science and technolgoy.

Someone has suggested that the wide adaptation of US 13 hybrid corn was one of the great disservices to our technical assistance programs. We found it very easy to transfer this particular hybrid into Western Europe, Italy, and Yugoslavia. This tended to indicate that the job of agricultural improvement was a simple one.

We failed to remember that the agriculture in northern Europe is similar to that of our Temperate Zone conditions, and that we can make a lateral latitudinal transfer.

We concentrated a lot of effort on extension and community development in the early days of Point IV. We developed extension organizations and methodologies, and we were concerned primarily with the realinement of existing resources in the less developed countries.

Many of our efforts were scattered. As Ambassador Galbraith has pointed out, we would send out a poultry adviser, he would spend 2 or 4 years advising, and when he left the cooperating country, or host, the chickens would go back to roost.

We concentrated on improving single institutions, not always oriented to the problems of the country or to the development process itself. These institutions were not necessarily associated into national systems of research and development. We failed again to recognize that the science and technology matrix in many of these countries was, and, in many cases, is still lacking.

The science and technology in foreign aid designed to increase food crop production has been rather limited. We have concentrated on the extension or transfer of our own crop varieties and our own production practices. We have not focused research attention on the increase of production of crops such as rice and wheat, which have been in surplus in the United States. This reflected the attitude of the Congress, of the American public, and of American farm organizations -- a handicap that is still to be overcome. I think this is one of the major jobs that we as scientists

and as people who are concerned with world food supplies have a responsibility for, to develop that kind of constituency that recognizes the importance of filling the massive food deficits of the next two decades.

There have been some selected exceptions to the lack of emphasis on research. The Rockefeller Foundation agricultural program has worked on food crop improvement, including corn, wheat, and other crops in Latin America and in Asia for more than 20 years. We are all familar with the progress in wheat improvement in Mexico, where the yields per acre were increased from about 11 bushels in 1943 to 39 bushels in 1965.

This is a current surge in the recognition of the need for science and technology to improve agriculture in the developing countries. The Rockefeller Foundation program, started in 1943 in Mexico and later expanded into Colombia, Chile, India, and Nigeria, is continuing to place heavy emphasis on research geared to increase food crop production.

I think one of the striking examples of shift in emphasis is in the attitude of some Ford Foundation personnel. The early emphasis of the Ford Foundation was on extension and community development activities. David Hopper, who has been in India over the past 7 or 8 years, has been reviewing the activities in the concentrated agricultural development program in that country. Two years ago he studied in some detail the progress in the Camilla project in East Pakistan, and in his report in August of 1944 he stated:

> The factors limiting output in the future will be the shortage of technical knowledge and the low quality of many inputs, especially crop varieties. As yet, there are no research programs in East Pakistan that hold promise of an eventual solution of these shortages.

Haldor Hanson, the Ford Foundation representative in Pakistan, has made a vigorous effort to increase attention to research to improve rice production in East Pakistan and wheat production in West Pakistan during the past 2 years.

F. F. Hill, who served as vice president for the International Programs in the Ford Foundation, at the meeting of the American Farm Economics Association this past December (1965), recommended that emergency research teams be sent into the food-deficit countries for the next 10 years to improve the varieties of the basic food grains, including wheat, maize, rice, and the sorghums and to give attention to techniques for their production as well as to the necessary inputs of fertilizer and pest control chemicals.

I mention these changes in attitudes of competent agricultural economists, particularly because I think they tend to blunt the biases of the biologists who have been preaching this approach over the past 10 years or more.

There are others who are becoming aware of the need for more attention to adaptive research. The U.S. land-grant universities of Illinois, Missouri, Tennessee, Kansas State, and Ohio State have been working in India for the past 10 years to help develop agricultural education institutions in the various Indian states. Two weeks ago today, the panel that was reviewing the role of the Indian agricultural universities in agricultural production and development stated:

> Their first responsibility and challenge is the infusion of modern science and technology into agriculture and agricultural production practices. While achieving this influsion, they must build the institutional base for a continued infusion of science and technology to support sustained progress.

Last week in Pakistan I had conversations with the agricultural officers of AID. Pakistan, you may recall, is one of the countries that has progressed the most rapidly in economic development during the past 5 years. It is one of the prize patterns of real progress growing out of the collaborative efforts in the AID program. Yet we find the agricultural officers of our government who are stationed there more or less unanimous in stating that we must have new information and materials for sustained agricultural development. We cannot depend any longer upon intuition and, as they put it, "gut reaction," to guide the technical assistance efforts. So long as we could say, "Sure, throw on another bag of fertilizer," we were okay. But now the question is whether we add more fertilizer or do something else.

As we look at the resources for international agricultural development, we should keep in mind that most of the food deficit and less developed countries are in the tropical or subtropical climates. U.S. materials and experience are not well suited to these climates, at least, they are not directly applicable. We are, however, finding growing research resources in other countries. The leading center for research on rice production and improvement at the present time is the International Rice Research Institute in the Philippines. This was established by the Ford Foundation, which put up about $7.5 million for the capital costs, and the Rockefeller Foundation, which is supplying together with the Ford Foundation the operating budget that runs about $1.5 million annually.

The institute has an international board of trustees and also an international staff giving attention to all aspects of rice production and use.

In India there are major rice research centers at Cuttack and at Hyderabad, and regional centers that are being established at Patna, Raipur, and several other locations. The Genetics Institute at Misima, Japan, and the work that H. H. Love of Cornell helped to

get established in such an excellent fashion in Thailand also are strengths in Asia.

For wheat research, perhaps the greatest reservoir of germ plasma that exists anywhere in the world is contained on 30 acres at the research station at Sonora, Mexico. Norman Borlaug has made many intervarietal and interspecific crosses of wheat, and has an amazing collection of material that has wide adaptation in the wheat-growing countries of the world.

The Mexican semidwarf varieties that will use up to 120 pounds of nitrogen and produce yields up to 120 bushels per acre have been rather widely heralded in India and in the Near East countries, as well as in Africa.

There are good research programs underway in a number of other Latin American countries, in Peru, Colombia, Ecuador, and Chile.

In the Near East there are about 30 young plant breeders from 11 different countries who have been trained in the wheat-breeding program in Mexico. I believe all but one of these young men are still engaged in wheat improvement research in their home countries.

We, of course, do not overlook the resources that we have in the United States. We can point with some pride to the fact that the highest yield of wheat that we are aware of has been produced in the State of Washington -- where the variety Gaines in the past season produced over 200 bushels per acre. This gives us some idea of the ceiling or the potential we have for increasing yields in countries such as India where the national average yield per acre runs about 12.5 bushels.

For sorghum and millets, one of the potential leading centers for crop improvement research is India. We have in India the world's most extensive collection of varieties, and work is underway to classify these races or varieties and also to classify their reactions to insects and diseases. These classification projects are carried under the Public Law 480 funds. In Africa a project on sorghum improvement, supported by the AID, is conducted by the USDA. We have, of course, important U.S. resources from Federal and State research that have contributed in producing the new sorghum hybrids that are being utilized now in India. These new hybrids trace back to the male sterile Kafir No. 60, which is the parent of most of the improved sorghums. Glenn Burton's millet lines from Tifton, Ga., have been used pretty largely as the basic breeding stock for the improved millets that have been bred in India.

For corn improvement, another major food grain, we can look largely to Latin America, where this crop is indigenous. In Mexico, Colombia, and Brazil are research centers and repositories for the seed stocks that have been collected through the collaborative work of the National Academy of Science, the National Research Council, working with the Rockefeller Foundation and the U.S. Department of Agriculture.

India is emerging as a major center for corn improvement work in the Far East, with collaborative work in Thailand, the Philippines, and in Indonesia. I think within a few years we may begin to see the emergence of an Asian corn belt, with these countries moving ahead very vigorously in corn production. This has been an especially important factor in Thailand, where corn has been one of their chief export crops and has added diversity to their former monoculture of rice.

One of the food crops that has had inadequate attention is the grain legume complex of chickpeas, mung beans, and cowpeas. These crops contain about 20 to 25 percent protein. In a survey made 2 years ago by the U.S. Department of Agriculture it was found that there was not one scientist devoting full-time attention to these particular crops in all of the Near East, South Asia, and Far East region. We now have a grain legume improvement project supported by AID, conducted by the USDA with headquarters in Iran, that is being expanded into India. We hope in time to extend this to Latin America and to Africa.

It is important that we weigh the whole iceberg, as Ted Byerly put it. The peaks of efforts abroad have their visibility, but the base of the materials, the methods, and the organization patterns trace back to experience in the work of the USDA and the land-grant institutions.

Now I would like to say something about adaptive research in food crop improvement as it relates to India. The Mexican wheats that have been tested in India for the past 3 years are short strawed, utilize high amounts of nitrogen, and produce high yields. But we know that they are susceptible to certain races of rusts. Also, in tests in India this past year they have demonstrated a susceptibility to loose smut. In addition, they are somewhat lacking in the grain quality that the Indians prefer.

The Taichung Native 1 rice has produced well in India, but it is susceptible to bacterial leaf blight, to the tungro virus disease, and also to the blast disease.

These weaknesses are significant because the Minister of Agriculture is depending heavily upon these materials to achieve self-sufficiency in food production in India by the year 1971-72. Disease-resistant selections must be isolated through adaptive research if this goal is to be achieved and potential disease hazards avoided.

With respect to cultural practices, the Mexican wheats in India must be tested and evaluated because the dwarfness in their mature plant stage also occurs in the seedling stage. They have a short coleoptile and therefore must be planted not more than $1\frac{1}{2}$ or 2 inches deep. Also, they require a certain amount of cool temperature at planting time in order to cause them to tiller and to

produce the full stands that produce high yields.

This past October was warmer than usual in India. Some of the Mexican wheats failed to tiller after emergence, and later, as the weather became cooler, they began to branch from the upper nodes.

Attention should be given to rotations, to exploit potential double or tripple cropping. The new wheats and the new rice varieties can mature in about a hundred days so it is possible to produce two or three crops a year with these crops and other food crops normally grown in India.

More attention will have to be given to fertilizer and water management, especially to the irrigation regimes. The water application schedule will have to be modified to apply the water at the time when the crop can use it, and to fit water application to stage of growth and maturity of the crop. In the first season of production the Mexican wheats, when old irrigation schedules were followed, the last water application was made too late to benefit the earlier maturing varieties.

We are aware, of course, that pest control problems will increase under intensive cropping and the supply of pest control chemicals, as well as the specificity of materials, will have to be evaluated and watched very carefully.

I want to return just a moment to the problem of diseases associated with the introduction of new plants into a new environment. In reviewing our experience with the stem rust race 15B, we find that this disease was first noted in farmers' fields in 1950. In 1953 we lost 60 percent of the durum wheat crop. The following year we lost 75 percent of it. In the case of the destructive oat diseases in the 1940's, we introduced a new basic breeding stock, the Victoria variety, from Australia, and crossed it with some of our native materials. Some outstanding varieties selected from these hybrids were released in 1941. By 1945 they had taken over 90 percent of the acreage in the Corn Belt. The Helminthosporium disease hit these varieties hard, with losses in 1946 up to 25 percent and in 1947 up to 32 percent.

We had other new selections coming along in the breeding nurseries, from the Bond parent, also an introduced material. We know that these new hybrids were susceptible to crown rust race 45 and also to the Septoria disease. In 1948, when the Bond-derived varieties were released, the losses were cut to 1 percent. From 1949 to 1953, however, as the new diseases built up, the losses ranged from 15 to 30 percent.

India's grain yields this year, of 76 million tons, are about 8 percent below the 1963 yields. Compared with the 1964 yields, the reduction is about 15 percent. We are well aware, from our own experience of the risks from introduction of new crop varieties into food-deficit countries. It is essential that we furnish adequate protection against hazards that we can anticipate. In the case of the Mexican wheats and the Taichung Native 1 rice variety, we already know what their weaknesses are.

We realize that the rapid introduction of new varieties with unknown, or in some cases known, disease hazards is a form of biological brinksmanship. We must protect some government leaders against themselves and against our enthusiasm for certain innovations, since we can identify some of the weaknesses of the things that we recommend, even though they are not in a position to do likewise.

In developing cooperative agricultural programs abroad it is essential that we recognize the need for national coordinated efforts. A nation's economic and political stability is closely tied to its food production. It has been stated that Mr. Khrushchev crumbled because of his agricultural policies. In India, 2 weeks ago, Minister Subramaniam was under fire because of his failure to meet the food crises.

National programs insure the maximum use of research resources. By combining the central and state government funds and personnel, to blend and mix combinations of talents of a geneticist at one center and a plant pathologist at another, limited numbers of staff can extend their efforts over large agricultural regions.

The ultimate target in our research program is the individual farmer who operates within variable environmental conditions. We are essentially establishing a scientific bucket brigade, starting at the main resource center -- whether this is the International Rice Research Institute or a national crop improvement scheme -- and moving this right on down to the individual farmfield.

We know from our own experience that the Imperial Valley is a long way from Beltsville. In Mexico, the Yaqui Valley is a long way from Chapingo. It is important, therefore, that we develop the kind of a system on a national basis that will provide for coordinated support and leadership but will stimulate individual research efforts throughout the country, as have our land-grant colleges, their experiment stations, and, through test demonstrations, to the farmers' fields.

We know also that nations must have their indigenous capability to meet production hazards. This is particularly true for the emerging nations that have come out of a political colonialism and do not expect to become submerged in a scientific colonialism.

In furnishing U.S. resources for cooperative agricultural science, it is important that AID on its "direct hire" staff have top level competence. It is important that we help to identify problems and evaluate programs on a countrywide basis. It is important also that we know the international scientific resources that relate to agricultural development. This competence is needed not only in the Washington offices of AID but also in the field, because this is where the problems are identified. This is where we must have the chief input in program planning.

As far as the collaborating U.S. universities are concerned, again we must have more adequate staff, not only in numbers but also in competence. Our foreign agricultural technical assistance efforts cannot be casual or intermittent. This is not a "Saturday matinee" exercise. We need qualified scientists and not only extension agents. There is need for continuity of attention. It has been suggested that a minimum of 10 years is required for some of the research efforts that we should undertake.

This, I realize, is one of the major handicaps that we have in developing effective working agreements under the AID program. But at the present time we are planning research that can be funded for 3 years and projected forward over a 10-year term. We all recognize the limitations of annual appropriations, but this is no different from the support for any other government agency, be it the U.S. Department of Agriculture, the U.S. Department of the Interior, or others.

We can arrange for greater continuity of attention by the more effective use of graduate students. For example, we might work out arrangements whereby U.S. graduate students would spend 1 year giving total attention to their academic training on the U.S. campus and then spend 2 years abroad. During this time they would work on a research program or problem of significance to the host country. They would then return for 1 year to complete their academic and thesis experience on the U.S. campus. By initiating a series of graduate student experiences of this kind, we could arrange for the necessary continuity of programs in many fields, such as soil science, plant breeding, and so on.

Our universities should give greater attention to the building of "international staff" capability. Here again I believe this is largely a Federal responsibility. We are proposing an amendment in the Foreign Assistance Act this year that would enable the use of AID funds to build greater capability into domestic institutions to permit them to participate more effectively in our foreign aid programs.

The universities will undoubtedly find it necessary to modify arrangements for staff evaluation and advancement. We cannot use the same standard measure of basic research and research publications for the personnel who work overseas as we are accustomed to for staff members engaged in domestic programs.

AID is looking forward to a greater degree of collaboration with the USDA. As Secretary Freeman pointed out yesterday, the AID organization has the authorization for work abroad, and we expect to undertake considerably more cooperative activity in the next few years under agreement with the USDA.

Assistant Secretary Jacobson has outlined the international food situation that confronts us in the years ahead. I think that we should all recognize that the short-term arrangements for food aid, through shipments from the United States, are not in conflict with the longer term arrangements for research and development. These types of assistance are complementary rather than conflicting. If we look at the significance of the figures that were placed on the board, the 42 million tons that would appear to be our shortfall in 1975 represent about 1.5 billion bushels of wheat, somewhat larger than the U.S. annual wheat crop of 1.2 billion bushels. This gives us some idea of the order of magnitude of the job we have ahead.

I have stressed research that is essential to furnish new inputs, but we recognize there are other factors that are important, including price policies, rural transportation that includes farm-to-market roads, the availability of fertilizers and pest control chemicals, and the participation of the private sector. There is increasing evidence that we need the thrust of the private enterprise system if we are going to make the rapid progress in convincing farmers that they should accept innovations.

There is ample evidence that the less developed countries are ready for innovations. When I was in India 2 weeks ago, they were reporting that some Indian farmers were bidding up to 25 rupees per kilo, or roughly $2.50 a pound, for seed of a new millet variety. Those of us who recall that it took some time to convince U.S. farmers that they should pay 10 cents a pound for hybrid seed corn in the 1930's have some appreciation of the desire and the demand on the part of the Indian cultivator for new materials and new methods. Of course, we have similar evidence in Mexico where the farmers in that country readily adopted the new wheat varieties and within 3 years had planted 85 percent of the country's wheat acres to the new dwarf and semidwarf varieties.

In closing, I would like to refer to a conversation I had 2 weeks ago with S. Swaminathan, an outstanding Indian plant scientist. As he pointed out:

> Our difficulty in infusion of agricultural science and technology, to modernize primitive or traditional farming practices, is not with the illiterate but with the literate. The man on the land is usually willing to accept the advances of science. It is the economic and political leadership in program planning and budget positions that limits the development of the scientific base for modern agriculture -- by constantly seeking expedient short-term answers to longer-term problems.

I think that it is up to the scientific community to demonstrate and to prove that we can build the launching pads for lifting the levels of food production in Asia, in Latin America, in Africa, as we have done in the United States.

DR. UPCHURCH: Thank you, Dr. Moseman, for this very informative talk. I read into it both an expression of hope and optimism, as well as an expression of the enormous job that lies ahead for us and for our neighbors around the world.

PANEL DISCUSSION -- FOOD FOR A HUNGRY WORLD

DR. UPCHURCH: We have, gentlemen, a bonus to offer you this afternoon before we go into the panel discussion. This bonus is in the person of Dr. Aaron Altschul.

DR. Altschul is head of the Pioneering Research Laboratory on Seed Proteins in the Southern Regional Research Laboratory. Dr. Altschul has become an internationally reknown scholar in the field of seed proteins.

We mentioned in our discussions yesterday on several occasions the fact that we can't measure the world food needs just by calories. So if I were to give Dr. Altschul a title for his speech -- he can correct me if this is wrong -- it will be something like "Calories Aren't Enough."

Dr. Altschul is going to talk to us briefly about his work in the plant protein field and how it fits into this world food needs problem. Then we are going to ask him to join the panel, with the Secretary and Dr. Moseman, and we will have then some time for discussion.

Dr. Altschul.

Remarks--Aaron Altschul

DR. ALTSCHUL: Mr. Chairman, Madam Secretary, I should like to add just a footnote to what has been said so well in the last two talks and point out another aspect of the impact of the technology on our approach to solving some of the world food problems. I would like to confine myself to the problem of increasing protein supply and to the point of view of the chemist. And I suppose in that regard as a sometime chemist, I'm going to try to say a word on behalf of the physical sciences.

I think that an approach of the chemist to this problem presents us with certain opportunities that maybe we hadn't had before or hadn't considered, and creates certain problems.

I might cite as the opportunities: broadened vision. We have heard a very excellent exposition of what might be done in the classical way of raising our food production. But if we play at being chemists then maybe we could decide that we need not depend entirely on classical methods of food production or on current photosynthesis. We might, for example, decide that we might use some photosynthesis that took place many millions of years ago: people are now making proteins from petroleum and lysine from petroleum. Or we might completely neglect current photosynthesis and think of nuclear energy as a source of food. In this way we are liberated from the confines of what we had considered as the only possibilities and have perhaps a little more hope to offer toward bringing population and food supply into balance.

But this opportunity creates with it certain problems. I'm speaking under the cloud of the question that was raised this morning about the fact that the apples don't taste as good now as they used to.

If we are to create other forms of food, then this must be done without lowering either the nutritional or esthetic or the prestige level of the food supply. It is very easy to compound mixtures that are nutritious, adequate nutritionally, but it is not so easy to get them eaten.

I would like to take a minute to say how does one approach this problem.

I think that in general one approaches this problem by creating new food artifacts. I would like to stress that point. We are very familiar with all kinds of artifacts but we are rather conservative about talking about food artifacts. If perhaps you are unfamiliar with that idea, let me point out that maybe one of the greatest artifacts of all time is bread, a food artifact. And so we now have to create new protein foods. This is not entirely unreasonable, and isn't that far out of the way.

We can talk about a broad spectrum of these foods. We can talk about the simple cereal-protein concentrate mixtures, which are simply variations of what we have been feeding very successfully to monogastric animals for a long time, and which are now being fed with some degree of success in various forms such as Incaparina, or Pronutro. These certainly have a place. They depend on the fact that one can now make protein concentrates out of the soybean, cottonseed, or peanut, that are nutritionally adequate and can be used in these mixtures.

But we are not limited to these kinds of artifacts. We can envisage -- and I think that this time is here already -- a variety of beverages, protein beverages. I think it is a very great social concept that we may look forward to the day that every child will have the opportunity to drink a protein beverage, flavored according to its social familiarity, adequate nutritionally, and something that they will drink.

There is a soy beverage in Hong Kong that is quite adequate and quite well taken. There are a number of companies playing with this concept of protein beverages; and I don't doubt that in the next 5 years we will have them not only in the United States but as

economically viable commercial operations in other countries.

We need not stop there. There are now a wide variety of textured foods made from protein concentrates. In their most elegant form they look like ham, beef, or bacon, but they don't have to. They can be entirely new forms, entirely new flavors. There is no real limit to the things that we can think about and that can be done with this approach.

I think that this is possible; I think this is going to happen. I think it is happening much faster than we think. I must tell you a story.

About 5 years ago I talked to some economists in our Department about these ideas and they told me that I was a hundred years ahead of my time. I said: Any fool can be a hundred years ahead of his time, the trick is to be 10 years ahead.

I finally found one that said maybe I'm 25 years ahead. But it is 5 years later, and we are in it now.

I think we have only seen the beginning of this new development. Probably the limiting factor will be the amount of information. This leads me to point out that there is a great need for continuation and expansion, as Dr. Brady pointed out earlier, of research in these areas -- research on protein concentrates; research on synthetic resources such as amino acids; research, as Dr. Moseman pointed out, in breeding plants for quality factors, in addition to yield, for more protein or for specific amino acids; research in finding out more about the fundamental properties of our resources so as to relate them to our functional needs.

What we are leading up to, I think, is that we may some day be able to go to a population and determine its needs, wants, and desires and design a product that will fill that need, then go back to the food scientist and say: This is what we want, can you make it? The hair spray people know how to do this. I think the food scientist may learn how to do it, too.

DR. UPCHURCH: We have laid out in these three talks a rather tremendous area of subject matter. We have far too short a time to discuss these things very thoroughly. We do have some time for questioning. This is a rare opportunity to get three people of the caliber that we have here together in one place at one time with sufficient time to answer some questions.

The floor is open for questions, gentlemen.

DR. JENKINS (NASA): Madam Secretary, there is some degree to which emergency food has to be given to some of the countries where there is starvation now. But the countries that are just developing, particularly those coming up from colonial rule, have a lot of urgent problems. If we relieve the major problem of food by giving them food or selling them food at the present time, isn't that self-defeating for the urgency for getting them to go ahead and develop their own agriculture?

MRS. JACOBSON: To answer that question is the chief reason why the new program, as distinct from our previous programs in food aid, emphasizes self-help.

The President, in his message on the new Food for Freedom program, said we would continue to help to fill the gap for those countries that are determined and that show a determination to increase their own food production.

The bill which the President proposed and sent to the Congress last week mentions four times within that very short bill the necessity of their own efforts. This has not been true with respect to our Food Aid Program up to now. There had been a hope that it would be used for economic development, to help economic development. But it has never been written in as definitely as now.

There is in the policy of the Administration and written into the program presented in the bill that food aid should not be used as a crutch, that it should be used simply as a help, perhaps to fill the gap, perhaps even to provide incentive for their own development. Your point is very well taken. It is certainly realized by the Government.

DR. MURDOCK: I have one question of Secretary Jacobson. As you noted, these countries, as with Israel, are doing the best to increase their agricultural productivity. Is either Pakistan or India one of these?

MRS. JACOBSON: Pakistan has shown a remarkable development. Dr. Moseman has referred to it. India's development has been, unfortunately, it seems to me, in spite of the fact that there have been these -- is it five land-grant colleges -- tremendous foundation resources poured in there. I don't know what all the reasons are, but I think the reasons do not relate to the scientific development. I think they relate to the human and social field.

I first met the present Minister of Agriculture, Subramaniam, last summer and got to know him a little better in Rome last fall. This was before the Indian crisis was apparent even to them, the monsoon failures being the immediate crisis. He sounded to me like no other Indian government official I had ever talked to before. He seemed to have a determination to fight hard for a greater input into the agricultural sector.

In talking with him and in talking with others, it seems to me that I became aware of certain things. In the first place, India, like so many of the developing countries, was hypnotized by the idea of entering into the modern age by industrializing in a hurry. And its scarce resources were directed primarily into the industrial field rather than the agricultural field. And in spite of what Dr. Ruttan said this morning, I think that agriculture has to develop to a certain level before industrial development can succeed.

They had certain prejudices against new products in agriculture in India. They have

had to fight up to almost the present. I think they have moved rather rapidly in the past year into the direction of giving the kind of emphasis that they need to give. The new, fourth 5-year plan, has a much greater emphasis on inputs into agriculture. Pakistan in the past few years has made some real steps forward.

DR. UPCHURCH: Ray Scott.

DR. SCOTT: Mrs. Jacobson, we have been talking about one part of the equation here this afternoon in terms of increasing food supplies and food aid as an effort to increase technology and improve productivity. I wonder how much consideration in terms of our policies and our conditions are being given -- conditions for assistance to the other side -- and that is in terms of population control.

MRS. JACOBSON: The United States Government has, within the last year or so, announced its policy that we will provide assistance in population planning and population control to those countries that have themselves adopted that as a policy and who ask for assistance. I believe that this government has never stated an official position that it would make population control a condition for aid. That has not been and probably will not be, for obvious reasons. There is some, but not as much as there used to be, serious opposition to this policy, even going as far as it has in the United States Government.

I think that our Government has stated rather forthrightly that it will provide assistance wherever it is asked for. I would say that in the countries where the population is most critical, the Government has an official policy to try to do something about it. This is very touchy. I have seen some communist charges that the capitalist rulers, the ruling class, want to keep down the growth of the population that is nonwhite. This is absurd, but it is an indication of why you can't say to these countries you have to control your population.

DR. UPCHURCH: Dr. Cain.

DR. CAIN: Mrs. Jacobson again. I want to ask a question about your 20-year curve on food needs. The first is, does it include as one of its assumptions any changes in population growth rates of the countries you are dealing with? The other question: Is this what we used to call the Free World -- does it include China and other countries like it?

MRS. JACOBSON: It is based on the United States median projections which I believe are based on a slowing of the rate of increase in population growth. Some. The U.S. has three. This is not the top rate or the bottom rate; it is the median.

I want to say that even if population control measures are successful -- and I happen to be an optimist on this, I think they will succeed in most of these areas -- within the next 15 or 20 years, it won't make much difference about the need for food because the majority of those people are living now. And one other factor that per capita figures don't show.

This sharp drop in death rates in the last 10 years has meant that there are far more babies living than would have lived before. We only need to remind ourselves of what we know about the different per capita needs of a baby 2 or 3 years old and a teen-ager to realize that when the swelling group of infants reaches the teen-age group, in the immediate future, there will be a big need.

Does this include the Free World only? Yes, it includes our aid-recipient countries, which means that basically it excludes only one significant area, mainland China. Neither, however, does the productive capacity include the production of Canada and Australia. So I guess the tacit assumption is that at present at least the Canadians are taking care of the Chinese.

MR. ELTON JOHNSON: I have a question or two for Dr. Moseman.

I would like him -- if he would be willing to do so -- to try to give us some idea of how Section 103, which is in the Foreign Assistance Act proposal, would give grants to educational institutions. How do you envision this being operated, presuming of course that the Foreign Assistance Act is passed, to include that? Also how does this relate to the $12 million in research funds which you now have? And thirdly, how does this relate to the International Education Act, Mr. Grainger's activity, in these particular areas and problems?

DR. MOSEMAN: It is a kind of a one-two-three punch.

On the administration of Section 103, the use of funds to strengthen our domestic capability, we haven't really worked this out in any detail. I think perhaps the first place we would start would be with those institutions that have contracts now. We would allow some liberalization of the use of funds to strengthen the staff capability.

The relationships with the HEW under the International Education Act again remain to be worked out. The concept is that the international education efforts will be tied to primarily the countries that are not involved in technical or economic aid. This will be an effort to develop and maintain an international exchange in the field of education and collaboration that goes beyond the technical or economic standards. In other words it would relate to Taiwan and countries where we have withdrawn economic aid, to Mexico and some of these other countries.

What was number 3?

MR. JOHNSON: How does this work in relationship to the $12 million research.

DR. MOSEMAN: On research, the $12 million that we have for a central research fund represents the theoretical amount that we have available for inter-regional or, let's say, international programs. This is not going to limit us, for example, in doing a lot of research if we feel this is necessary through the university contracts or through other country-oriented programs. Because if the University of Missouri is working in India, the

Near East region -- the Indian mission -- can support research under that university contract. Or if there is a research project that is undertaken specifically for Nigeria or for a given country, the country mission can finance it.

So I don't look upon this $12 million limitation as any real handicap in developing a real broad effective research program within the agency.

MR. JOHNSON: You would expect the new paragraph to be in addition to the $12 million?

DR. MOSEMAN: That's right.

MR. JOHNSON: For support of research?

DR. MOSEMAN: Yes.

DR. UPCHURCH: Gentlemen, unfortunately the hand on my watch keeps moving around. We do have a time schedule to meet, and transportation schedules to meet for many of you. While this is a subject that we could continue with profit for many hours yet, I'm sure, I'm going to use the prerogative of the Chair to recess this part of the program with my most sincere thanks, Madam Secretary, Dr. Moseman, Dr. Altschul, for your contribution to this part.

The final item on our program is labeled "Summary." I think this obviously is a misnomer. It probably should be called concluding remarks or something of this sort. It is to be handled by a man whom I have known for many years and have enjoyed exchanging appreciations with over many different capacities on both his part and mine -- the Assistant Secretary of Agriculture, George Mehren.

CONCLUDING REMARKS -- GEORGE L. MEHREN

MR. MEHREN: I'm quite frankly homesick for what might be euphemistically called the quietude and tranquility of the Berkeley campus. At Berkeley I lived on a street called Shasta Road. Shasta Road was a narrow and twisted little lane that wound up the side of the hill affectionately known to the natives of the community as "Nut Hill." It was called Nut Hill because a rather remarkable population of scientists inhabited it. It was an informal understanding there that nobody invaded anybody's privacy.

In the little neighborhood within walking distance there was an excellent lawyer, a very good labor economist, a mathematical psychologist, two Nobel laureates in physics, a playwright, two very good novelists, and a great many different people, and perhaps especially, Alex Micheljon, who, to me, was a great gentleman. There was an implicit understanding again that one could say anything he chose, but he could not act as expert in his own field.

In consequence, one of the physicists became one of the great experts on exchange balance and was able to prove, and willing to prove at the drop of a hat or even without the drop of a hat, that the way for us to solve our exchange balance difficulties was just to quit importing and quit exporting and everything would be dandy.

So I learned long ago that pleasant and gracious cross-disciplinary talk among people of reasonable competence in any field is not difficult. And I have learned also that if people on an operating basis are locked up together on research involving common targets, that disciplinary differences are really minor differences. And this I think has been amply proved again here.

For me at least it has been two delightful days. And I wish we could do them oftener.

It seems to me that with respect to the fundamental purposes of this session, there have been agreements and disagreements. There has been expression of self-interest, and I think quite naturally and normally, and perhaps desirably, there has been quite unequivocal and uninhibited expression of bias.

The purposes of this meeting generally were for us to hear from people in other disciplines what they think about the total structure of this complex battery of research operations involving us and all of the States. And the other purpose on our part was to tell you as frankly and with as little bias and self-interest as is possible what this research mechanism called agricultural science is, who we are in terms of people and competence, what we do and why we try to do it, how we are set up, and what we think we might be doing in the future.

I think maybe I could, if I were permitted to drop back to elementary logic 1-A, quickly frame up a sort of a little blackboard outline in terms of which perhaps we can specify the areas of agreement and disagreement with respect to fact, and the areas of agreement and disagreement with respect to the prescriptions that seem to be coming to us from this group.

I think there was unequivocal agreement by all concerned, explicitly or otherwise, that there is a complete structural identity of research processes in any field, hard or soft, live or physical, social or behavioral.

And I think there was complete agreement that the immediate usefulness of scientific inquiry or research is most drastically limited, that no scientist ever asks or answers a very useful question because he can't ever engage any of the issues that are of substantial interest to people as people. And I think all agreed that this must, or course, be maintained. It must be maintained because if it not be maintained, then the usefulness of scientific inquiry as one phase of policy formulation and program activity designed specifically to get targets would be sharply minimized.

The processes of research, it seems to me, start out with the specification of a particular type of question. Crudely speaking the question

always is, and always must be, like this: If Y varies or changes its magnitude, what other variables change with it; what are the net relationships of these variables to this or this set; and what is the overall system. That is what you do first.

And the second thing you do is to formulate a hypothesis in any field, and crudely speaking a hypothesis is a sort of a tentative explanation. In a large measure it determines your data and all of their major attributes; it determines, in some measure at least, your testing methods.

The third thing you do is apply your testing methods, and you establish your criteria either to reject or to not reject that hypothesis. These things we do in any field of research regardless of what the subject matter is.

The last thing you do is to develop an answer. And an answer I think in a research process is a substantially different thing from what this word means in the lay conversation of lay people who aren't acting like scientists.

The answer could have probably two basic uses. One of them would be to sharpen or heighten the effectiveness of research methodology itself, and there I suppose is something of a rough, not exact, but a rough synonym for basic research. The other one is pragmatic application, which means something substantially different. It means that if you want to know how really to change this (referring to Y) it tells you which ones of these you might manipulate to make this change. It tells you which of the relationships or what elements of the system could be changed by given magnitudes to achieve given magnitudes of your dependent target variables. That really is the role again, I think, of research or applied research in program activity.

The disagreements and the prescriptions during the 2 days we have been here seem to involve three major sets of issues.

1. How under the constraints of given resources for research activity do you balance your work among the questions you ask, among the methods used to answer the questions, or the ways in which you use the answers after you get them? On this I think, to put it mildly, there was lively disagreement. In some of the papers, as I recall them, there was lively inconsistency.

2. How do you organize at all levels from the individual operator to the group, to the laboratory, to the Department, to the complex of Federal-State activities?

3. What measure of coordination in each one of these elements, among all of these agencies, should be sought and how should you go about getting it?

If we run briefly over what again quite truly I think were papers of superb intellectual quality, and discussions which were excellent, there were things that puzzle me now, and perhaps a synthesis or set of conclusions with respect to what really was told to us in these 2 days can come only after careful study of what I hope will be a meticulously accurate transcript.

Dr. Seitz started a discussion which deviated very sharply from the kind of a discussion that one would expect from a man who ended with a prescription that more basic, more unoriented research, this kind of thing, degenerated by asking different types of questions. But he also opened his paper with what he called the gross problem in agriculture, and he used India, the same as Dorothy and Al have been talking about today, as a beautiful example of a gross problem. He parallelled it with what he called a microscale problem, again from India, that is a massive projected imbalance of people and food; and second, to set a far more precisely defined question relevant to diet composition, to nutritive reactions. Then he went on to say that in one measure USDA has failed, and especially the research elements of the USDA have failed.

He said we need to broaden our base and to shift our research activities away from the generation or the handling of surpluses, get away from barren land, and then assume a proper role which would bring it together with other institutions, the use of research machinery of this Nation for the purposes of social betterment. And that is applied research, and I'm not quite certain that I know really which way Dr. Seitz wanted us to go.

Dr. Brooks gave a beautiful paper, I think, and he handled it superbly. The discussion that followed it was as sharp as the edge of a razor. He noted that there was some basic difficulty in the responsibility of a scientist who has to answer up to Government or to society at large for results, and yet who wants basically support freedom.

He did note that what we are is vastly different, in terms of our own attributes and especially in terms of our relationships or comparisons of us with other people in the past short 25 years.

He then distinguished between what he called old patterns of research and new patterns of research. He said one attribute of the old is emphasis and operation through institutions, whereas the new people have an emphasis on program and project. He said that old people like us -- and I don't think there was a direct statement that the research components of this Department were moribund or had entered into a state of euphoria, or senescence, despite what might be said about some of the individuals who might be involved in it -- we were a market-directed outfit, he said, and the new ones were a science-directed outfit. He said we were Congressionally controlled as an old agency, and in large measure we are.

He said the new science operations have developed in a period in which the Executive is far stronger than it used to be, and in consequence there is far greater latitude for judgment. And he said that our programs were oriented to need, the kind of a need I

think to which Dr. Seitz in the preceding speech had particularly directed us, whereas the new ones are opportunity oriented, and he spoke praisefully of scientific solutions looking for problems.

Dr. Handler's speech I thought also was beautiful. But not basic. He emphasized most strongly that population control is imperative. Then he said we need a basis to insure that our productivity is used, and used effectively, to meet some glaring and obvious necessities. He outlined some ten areas in which he thought our work should be expanded, or new work should be initiated. And nearly every one of them meets the test of applied work.

We had a discussion from the President of the University of Missouri, which, again, I thought was a beautifully presented paper, in which perhaps some measure of self-interest showed. And I think among other things he indicated that which any reformed university administrator of research -- if there is or ever could be such a thing as a reformed university administrator of research -- likes a bit to be the boss. One of the ways to be the boss is to run the money. And one of the other necessities of being the boss is to take responsibility with it, and I suppose some measure of authority should generally go with responsibility. You don't always get this as a university administrator. He said really that there had to be continuing support, and the reasons for that are clear.

He said also that the support had basically or primarily to be institutional, and he indicated that the operating necessities of maintaining a university, which has many purposes other than the generation of scientific activities, could function well.

And then there was a man who is absent, and whom I know very closely. I know this man who gave me this gracious and somewhat gratuitous introduction here, and were he here I would be no more able to speak well of Dan Aldrich than Lou Upchurch dares to speak well of me in my own presence -- but he is gone.

Dan Aldrich does have a research and educational opportunity that comes to few men in this world. He has been building for about 5 years, and building from the naked group, a university which now has 1,600 kids in it but which within a few years will have 27,500, with about 15,000 of them undergraduates, and employees in the number of about 6,000. And he is designing a city -- literally designing a full city of some 100,000 people to go around its edges.

But more important, Dan Aldrich is putting together a research and education agency free of any of the constraints that impinge upon administrators who inherit it from somebody else. And Dan has decided that agriculture is everything. I think that is what he said. The theme of his campus is the relationship of man to his environment or the environment to man.

And I think really that when Dan got through telling us what environment was, and what agricultural assistance was, that any old distinction by disciplines, by applications, was, in fact, obliterated. And perhaps that is where we will end.

But Dan, I think, did this: He said that organization has to be tailored to purpose. And I think that is true. He said also the problem-solving work really has to be done on a team basis and on an exact design basis. And then Dan rode a horse, perhaps more vigorously than other people rode that same horse: That the great area of weakness in the research machinery of the Department and of the States and of the people associated with them involved a set of questions involving social and political patterns of variation. It is here, he said, that the important questions are, and here we failed to specify or put appropriate emphasis on these. This I don't know to be true or untrue, because on this I have my own biases since I came out of that kind of a background. This is one I think we will have to battle about a little bit, too.

There was an excellent speech last night by Dean Price who first talked about a sort of Jeffersonian vision, and he talked about procedures whereby this Jeffersonian vision might once again be made a reality, assuming that there ever was a Jeffersonian reality, and assuming that you could replicate today a Jeffersonian reality, and assuming that Dean Price actually would like it very much if he did replicate it.

What he told us generally is that we are a little bit like on basic research, that he has his doubts that, as he put it, agriculture can hold its own in this increasingly competitive pattern of interrelationships. He said we are unduly conservative, that we are dominated by the colleges -- which is interesting after what the colleges said to us yesterday -- and today -- that we are dominated by commodity groups, and that we are dominated by Congressional committees, and that, in short, we need many more strings on our bow.

I think Don said, among other things, that science can attain its full role probably only if it has a far wider measure of freedom of Congressional direction than we have.

These I think were the main things that were told us.

We spun out a statement of the objectives of this Department which go way beyond those of farming, and always have and encompass a battery of specific targets about 95 percent of the activities of which have no relevance to on-farm activities.

The first thing that comes clear, I think, is that the activity analysis of the Department missions will one day have to be crossed over against those of related and perhaps unrelated Departments. Decisions with respect to the interconnections, complementarities, the gaps or the competitive relationships among similar activities or relationships will

one day have to be considered at least a resolution.

One of the shocking elements of our own presentation is that now for the first time we and the States together, and to a lesser degree the industries, can indicate with substantial precision what we really have been doing. In some ways it looks good; in some ways it looks bad. In some ways it looks out of this broad, broad, broad battery of targets which have been allocated to this Department, we are in effect concentrating on only one -- and that is the production of food and fiber and timber products.

And in some measure it looks as if other target activities, program activities, of which Mrs. Jacobson's is an excellent example, are either totally bereft of any research backstopping which might show them alternative ways of achieving some pattern of economic development, or that in many other cases important applications of the Department have not been tested by research with respect to procedures whereby those targets might be gotten optimally. There is apparently about a one-third and two-thirds division here.

There was conflicting evaluation among people who looked at our work and told us about our work here with respect to whether we have enough of this on the basic side, or don't have enough. Are we really building and holding a core of straightforward scientists without any adjectives of applied nature in order to maintain viability for whatever else we had to do in the future? I don't think we suffer very much in that way. But it, too, has to be looked at.

Now, then, it seems to me that what we have to do is to go home and sit down with Dr. Maclay and his group, Dr. Irving, Dr. Byerly, Dr. Upchurch, Dr. Jemison, all of our research agencies and the States, and we have to ask ourselves these questions:

Do we really need to look at our own activities, our operating programs, including those of the State universities and make an honest analytical effort to determine whether or not some of our missions, operating missions not now supported by research, should so be supported?

I think we need to take a most careful look at the validity of the allegations with respect to the inappropriate balance between basic and applied work.

I think we have to look at the organizational matters of institutional versus contract versus systems grants to determine a tenable basis of obtaining funds and allocating funds among different parts of this machinery.

I think also we clearly now have to find some means for coordination at perhaps a dozen different levels. By "coordination" I mean continuing and systematic integration of our research activities with those of a great many other people.

I think it is clear, to me at least, after these two days that we need careful appraisal of whether or not within the Department's seven research agencies operating fundamentally on an autonomous basis, that we are making use of any complementaries that might be there.

Much more important is the necessity that we try to make the Office of Science and Technology in the Federal Council on Science and Technology a real coordinating mechanism to try to assure some measure of consistency in the science work of our Department with that of the other Departments.

I think we need to do the same thing with the States, and I suppose ultimately we should look for some way to do it with industrial research.

I have enjoyed it immensely. I hope you have too. I don't really go home with any answers, but I go home with some fascinating questions.

Thank you very much.

(Whereupon, at 3:30 p.m., the symposium was concluded.)

LIST OF PARTICIPANTS

DANIEL G. ALDRICH, JR., Chancellor, University of California, Irvine Campus

A. M. ALTSCHUL, Head, Seed Protein Pioneering Research Laboratory, Southern Utilization Research and Development Division, Agricultural Research Service, U.S. Department of Agriculture, New Orleans

T. F. BATES, Science Adviser to the Secretary, U.S. Department of the Interior

J. S. BETHEL, College of Forestry, University of Washington, Seattle

N. C. BRADY, Director of Research, Cornell University, Ithaca, N.Y.

HARVEY BROOKS, Chairman, National Academy of Sciences Committee on Science and Public Policy, and Dean, Division of Engineering and Applied Physics, Harvard University, Cambridge, Mass.

HARRISON BROWN, Foreign Secretary, National Academy of Sciences, and Professor of Geochemistry, California Institute of Technology, Pasadena.

GEORGE M. BROWNING, Associate Director, Iowa Agricultural Experiment Station, Ames

T.C. BYERLY, Administrator, Cooperative State Research Service, U.S. Department of Agriculture

STANLEY A. CAIN, Assistant Secretary for Fish and Wildlife, U.S. Department of the Interior

JOHN S. COLEMAN, Executive Officer, National Academy of Sciences, Washington, D.C.

CHARLES L. DUNHAM, Director, Division of Biology and Medicine, Atomic Energy Commission

H. H. ECKLES, Assistant to Science Adviser to the Secretary, U.S. Department of the Interior

ELMER ELLIS, President, University of Missouri, Columbia

E. C. ELTING, Associate Director, Research Program Development and Evaluation Staff, U.S. Department of Agriculture

K. C. EMERSON, Assistant for Research, Office of the Assistant Secretary of the Army for Research and Development, Department of Defense

ORVILLE L. FREEMAN, Secretary of Agriculture

SIDNEY R. GALLER, Assistant Secretary for Science, Smithsonian Institution, Washington, D.C.

PHILIP HANDLER, Chairman, Department of Biochemistry, Duke University, Durham, N.C.

LOUIS E. HAWKINS, Director, Oklahoma Agricultural Experiment Station, Stillwater

G. W. IRVING, JR., Administrator, Agricultural Research Service, U.S. Department of Agriculture

DOROTHY H. JACOBSON, Assistant Secretary, U.S. Department of Agriculture

G. M. JEMISON, Deputy Chief, Forest Service, U.S. Department of Agriculture

DALE W. JENKINS, Chief, Environmental Biology, Office of Space Sciences and Application, National Aeronautics and Space Administration

HAROLD R. LEWIS, Director, Office of Information, U.S. Department of Agriculture

W. D. MACLAY, Director, Research Program Development and Evaluation Staff, U.S. Department of Agriculture

CHARLES L. McCABE, Deputy Assistant Secretary, U.S. Department of Commerce

WILLIAM D. McELROY, DEPARTMENT OF Biology, Johns Hopkins University, Baltimore, Md.

RUSSELL McGREGOR, Bureau of the Budget

B. D. MAYBERRY, Dean, School of Agriculture, Tuskegee Institute, Tuskegee, Ala.

GEORGE L. MEHREN, Assistant Secretary, U.S. Department of Agriculture

FOSTER E. MOHRHARDT, Director, National Agricultural Library, U.S. Department of Agriculture

A. H. MOSEMAN, Assistant Administrator for Technical Cooperation and Research, Agency for International Development, U.S. Department of State

GEORGE P. MURDOCK, Professor of Anthropology, University of Pittsburgh, Pittsburgh, Pa.

A. G. NORMAN, Vice President for Research, University of Michigan, Ann Arbor; and Chairman, Division of Biology and Agriculture, National Research Council, Washington, D.C.

C. E. PALM, Chairman, National Research Council Agricultural Board, and Dean, New York College of Agriculture, Cornell University, Ithaca

DON K. PRICE, Dean, Graduate School of Public Administration, Harvard University, Cambridge, Mass.

JOHN K. ROULEAU, Science Officer, Office of International Scientific Affairs, Department of State

VERNON W. RUTTAN, Head, Department of Agricultural Economics, University of Minnesota, Minneapolis

E. E. SAULMON, Deputy Director of Science and Education, Office of the Secretary, U.S. Department of Agriculture

RAYMOND C. SCOTT, Assistant Administrator, Federal Extension Service, U.S. Department of Agriculture

FREDERICK SEITZ, President, National Academy of Sciences, Washington, D.C.

HOWARD B. SPRAGUE, Executive Secretary, Agricultural Board, National Academy of Sciences, Washington, D.C.

RUSSELL B. STEVENS, Executive Secretary, Division of Biology and Agriculture, National Academy of Sciences, Washington, D.C.

RUSSELL THACKREY, Executive Secretary, National Association of State Universities and Land-Grant Colleges, Washington, D.C.

M. L. UPCHURCH, Administrator, Economic Research Service, U.S. Department of Agriculture

LeROY VORIS, Executive Secretary, Food and Nutrition Board, National Academy of Sciences, Washington, D.C.

B. C. WEBB, Dean, School of Agriculture, Agricultural and Technical College of North Carolina, Greensboro

EDWARD WENK, JR., Chief, Science Policy Research Division, Library of Congress

E. WENTWORTH, Washington Post, Washington, D.C.

JOHN T. WILSON, Deputy Director, National Science Foundation, Washington, D.C.

☆U. S. GOVERNMENT PRINTING OFFICE : 1966 O - 223-902